THE

Malayan Agricultural Journal.

AUGUST, 1933.

EDITORIAL.

Malayan Soils. The present number of the Malayan Agricultural Journal contains an article dealing with Malayan soil types, by Mr. J. H. Dennett, of the Soils Division of the Department of Agriculture, S.S. and F.M.S. This paper is the first of a series of four which it is proposed to publish in this Journal under the general title of "Studies in Malayan soils". The paper is prefaced by a general introduction to the series by the Director of Agriculture in which certain modern views on soil science and their application to Malayan conditions are set out.

These papers will give an account, so far as possible in non-technical language, of some of the important factors governing soil fertility under the conditions obtaining in Malaya, and of the results of certain researches on the question which have been undertaken during the past three years.

Padi Stem Borers. In common with other agricultural crops padi is attacked by numerous pests, amongst the most important of which, in certain areas in Malaya, are moths whose larvae bore into the stems of padi plants and cause considerable loss by interfering with the production of grain.

Reports are received every season from the rice growing districts of this country of damage caused by stem-borers to the crop, and it is evident that the insects are responsible for appreciable damage and reduction in yield in certain areas.

The most important of these stem-borers in Malaya, are insects belonging to the three genera Diatraea, Schoenobius and Sesamia. For some years experiments aiming at control of these pests have been in progress in Krian, in the hope that a method of dealing with the outbreaks may be evolved which will lead to increased production of rice as a result of minimising the losses directly due to stem-borer attack.

The article contributed to the present number of the *Malayan Agricultural Journal* is a record of experimental work in this connection, in Krian during the 1931 - 1932 Padi season.

The insects mainly responsible for the damage are difficult to control by the ordinary measures usually adopted against pests, particularly since the whole of their larval stage is spent inside the stem of the attacked plant and they are thereby protected.

Another species of stem-borer—Scirpophaga—is controlled in Java by flooding and by crop rotation, but, in Malaya, the species of stem-borer mentioned above are not to any extent affected by flooding, and rotation of crops is not extensively practiced. In former experiments, the results of collection of moths attracted by light traps were not very encouraging, and it was considered that the most promising line of attack would probably be the adoption of some form of biological control.

The practice of this method of control originated from the fact that many injurious insects can be parasitised at some stage of their life history by other species, and that many injurious plants are attacked by insect enemies. The importation of an insect pest or an injurious plant into a country where its natural enemies do not exist may have serious consequences, and, of recent years, the practice of importing the known natural enemies of an insect or plant has come into prominence.

As instances of the value of the method, the beneficial effect of the importation of *Ptychomyia remota* into Fiji from Malaya for the control of the coconut leaf eating caterpillar—*Levuana iridescens*—and of the importation of a moth—Cactoblastis—into Australia for the control of the prickly pear may be mentioned.

Several local parasites of Malayan padi stem-borers have been studied, and the article now published contains the results obtained in the experiments with a parasite of the eggs of stem borers.

The parasite—*Trichogramma minutum*—attacks the eggs of Diatrea and to a certain extent those of Schoenobius, and was chosen for trial in the Krian area, where experimental liberation was made on a number of selected sites as detailed in the article.

The investigation has shown that Trichogramma is not an effective parasite of padi stem-borer eggs even when the total rate of liberation was 1,300,000 parasites per acre.

It is evident therefore that further work will be required before efficient measures for the control of stem-borers can be recommended.

Padi Sawahs as Pasture Land.

The establishment of agricultural services in Kedah, by the appointment of a Principal and of an Assistant Agricultural Officer, has made it possible to obtain information concerning many agricultural matters in this territory. Situated as it is in the north of the Peninsula where the climate is somewhat different to that of the F.M.S., and where there is a large Malay population engaged in rice cultivation, Kedah presents certain problems different to those obtaining in the more southerly States and opens up a new field of enquiry into established practice in rice cultivation, in an area where rice has been grown on a large scale for many years.

The article published in the present issue of this Journal, is a contribution from Mr. W. N. Sands, Principal Agricultural Officer, Kedah. It describes the natural vegetation of the rice lands in North Kedah in the period of the intercrop, and is a valuable ecological study of the flora in this region.

In the *Malayan Agricultural Journal* of June, 1932, reference was made to the cultivation of rice in Italy, where a system of alternation of rice growing with pasture land for grazing and with another crop such as wheat has been successfully adopted. In Kedah and in Kelantan where it is the practice to graze cattle on the sawah land, the prospects of adopting a somewhat similar type of rotation are considered worthy of investigation, and the account now published of the grasses and other forms of vegetation which normally appear in the sawahs in Kedah is of importance in this connection.

Reference is also made to the possibility of improving local pastures by selection of useful indigenous species of grasses and by introduction of exotic species. Some of the difficulties which may be expected to arise in attempting to establish pasture areas on padi sawahs are described, and it is pointed out that amelioration of soil conditions by the provision of effective drainage is of primary importance.

It should also be realised that if, in addition, the land is utilised for the cultivation of other food crops, during the period between harvesting and sowing, free grazing of cattle is not to be encouraged, and the provision of some form of fencing would appear to be essential, on areas intended for grazing. Controlled irrigation would naturally be of great assistance in the successful operation of any such scheme.

STUDIES IN MALAYAN SOILS.

Introduction.

BY

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Director of Agriculture.

In this and in succeeding numbers of the *Malayan Agricultural Journal* will appear a series of four papers by members of the staff of the Soils Division of the Department of Agriculture under the general title of "Studies in Malayan Soils". The object of this series is to provide, so far as possible in non-technical language, a general account of some of the more important factors governing soil fertility under tropical conditions, and particularly under Malayan conditions, and of the results of certain researches thereon undertaken during the last three years.

In no direction have ideas moved more rapidly and undergone a greater change in orientation than in the case of soil science. The days are gone when it was supposed that all that was necessary to ascertain the manurial requirements of a crop was to perform an analysis of the soil with the object of finding out what, if any, manurial constituents were deficient and then to supply the deficiency by means of dressings of fertilisers.

At the present time *the outstanding fact is that the best index to the condition of the soil and its requirements and deficiencies is the behaviour of the growing plant*, and more and more have soil scientists come to rely upon the plant as the most reliable source of information. The modern tendency is to note the behaviour of plants under varying methods of treatment, when grown under controlled conditions on particular soils, and then to endeavour to correlate the information so obtained with the observed chemical, physical and biological properties of the soil itself.

These four papers will illustrate this method of approach and the type of information which can be obtained from it.

In so far as Malayan soils are concerned, there is a popular belief that they naturally represent soil types of almost inexhaustible fertility and this belief is apparently supported by the fact that in few if any countries, which have attained a similar stage of development, has the use of fertilisers and manures become less generalised.

It is further apparently supported by the luxuriant clothing of tropical vegetation which originally covered the country from one end to the other and of which vast areas still remain untouched, and by the fact that rubber, the principal crop will, under the majority of conditions, go on giving satis-

factory yields for long periods without manurial applications while similar remarks apparently apply, in many cases, to the crops which occupy the second and third largest areas, namely rice and coconuts.

In point of fact this assumption of great fertility is a fallacy. Malayan soils are normally of considerable age and are distinctly deficient in plant food constituents. Under the climatic conditions prevailing in this country, they have been steadily leached of a large proportion of their fertilising constituents; consequently after they have been cleared they rapidly show signs of impoverishment with continued cultivation, particularly under annual crops. The fact that rubber rice and coconuts can be and are grown for long periods without fertilisers is in large part due to the fact that, apart from the material actually required for the building of the tree itself, the demands for plant food made by the rubber tree on the soil are almost negligible, while in so far as the other two crops are concerned they are practically entirely grown on alluvial soils which, being composed of transported material brought down from the higher lands, differ from the generality of soils in that, by their origin, they tend to be richer in plant food, and, being fine grained in texture, the plant food contained in them tends to be more readily available.

It is when we come to consider the cultivation of annual crops that the truth of this assertion is most plainly seen, and this is particularly well exemplified by the general attitude towards tapioca which is erroneously regarded as a dangerously exhausting crop, the cultivation of which should only be permitted under the most rigid restriction.

In point of fact tapioca is no more exhausting than many other annual crops; its reputation in Malaya is largely due to the fact that it has been extensively cultivated on naturally poor soils without any steps being taken to replenish the plant food removed.

The first paper in this series is a general one and deals with Malayan soil types, their mode of origin and general characters.

In the second paper, the question of measures necessary to the maintenance of fertility when annual crops are grown will be dealt with; apart from the question of the supply of plant food, the dependence of the soil on a continual supply of organic matter is emphasised. In many of the older tropical countries, especially those in which the area available for cultivation is geographically circumscribed, *e.g.* the West Indian Islands or Mauritius, where sugar cane is the principal crop, this problem has been solved by the utilisation of the excreta of the large number of farm animals employed for cultivation and haulage in crop operations, for the production of pen manure on a large scale. It is undoubtedly due to this practice that it has been possible to grow consecutive crops of sugar cane, on these lands, in some instances for close on two hundred years. When this provision is absent, as in Demerara, it has been found that, notwithstanding the extensive use of artificial fertilisers, non-productiveness is ultimately liable to ensue.

The maintenance of the supply of soil organic matter, quite as much as the maintenance of the supply of plant food, is therefore a key to success in agriculture in the tropics, and, in a country where industrial conditions do not call for the upkeep of large herds of cattle, the means of supplying organic matter to the soil is of very considerable importance.

To the solution of the problem the studies contained in the second paper of the series will constitute a contribution.

The third paper will deal with the relationships of organic matter and nitrogen in the soil, and will contain an account of investigations concerning the complex processes which obtain in this connection; these, it should be added, are definitely dissimilar in certain respects to those which obtain under temperate conditions.

The fourth paper will contain results of experiments on a field scale wherein certain of the points brought out in the previous papers are tested and demonstrated.

The soil represents the most valuable natural resource which a country possesses; the skill of the agriculturist is measured by the degree of success with which he utilises and conserves this asset. Viewed in its proper light, soil science is of fundamental importance; proper care and attention to the conservation of the soil should be quite as much a duty of a Government or of a nation as, for instance, the conservation of the mineral resources or the forests. The provision of special soil bureaus and soil surveys is a new feature of many of the more progressive countries. The further extension of such provision is bound to be only a matter of time.

This series of papers will, it is believed, assist in demonstrating the value of such work and, at the same time, serve to throw some light on the many obscure but important points which must be understood if the soil of this country is not to be a wasting asset.

I. THE CLASSIFICATION AND PROPERTIES OF MALAYAN SOILS.

BY

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A. General.

In making a study of soils there are one of two usual methods of approach, that of the soil scientist and that of the husbandman.

The term soil scientist is here applied, in the restricted sense, to a scientifically trained man who has taken up the study of the soil for its own sake. His approach is concerned, primarily, with purely scientific aspects of the soil considered as an object for philosophical study, with its genetic relationships with

other soils, and the parent material from which they are formed. The interest does not lie in the fact that one soil will yield twice as much of a given crop as another soil. On the other hand the husbandman is only concerned with the soil as a medium for plant growth. His standard of classification is its utility for his own particular purpose. He feels it is of no interest to know that his soil was formed by the leaching out of one constituent, by the accumulation of another; his criteria are solely the amount of crop and pasture the earth will yield.

Which then, if the choice must lie between these two, is the better approach? The latter method offers many disadvantages when it comes to opening up new land, for at least a season, possibly many seasons must elapse before he may know definitely whether the land is suitable for his purpose. On the other hand will the pure science method take any account of the husbandman's point of view?

The solution seems to be to have husbandry as the goal and approach it through the scientific method. By scientific observation of the soil yielding a certain crop it should be possible to predict other areas suitable for that crop. The methods of investigation employed and the results obtained might be termed scientific agriculture. If scientific facts about the soil are to be collected for correlation to husbandry it is certain that these facts must be systematised.

One of the first things therefore to be evolved would appear to be a suitable classification of soils.

The Rocks as Parent Material and Soil Classification.

It was but natural that the earlier soil surveys used the geology of the parent material as a basis for classification for it seems quite reasonable that the same rock should give rise to the same soils. As work progressed came the realisation that although this was often the case, at times dissimilar rocks gave rise to the same kind of soil while similar rocks gave rise to diverse ones.

As investigation progressed it was recognised, chiefly in Russia and America in the first place, that soil could be broadly divided on a climatic basis and finally the climatic classification was evolved; more truly the classification might be called the climato-geological one for it clearly recognises that geology is concerned in the soil formed within the broad climatic basis. The older geological classification on the other hand ignored the climatic effect.

Put in its briefest terms the climatic classification recognises that a soil formed (say) from granite will be different in a dry climate from a soil formed from a similar granite in the wet tropics. Further it implies that two soils formed from granite and (say) dolorite respectively, if under the same conditions of climate, will tend, in the course of time, to become identical.

It is to be expected that mature soils formed under the same climatic conditions will bear certain general resemblances whatever their parent material while young freshly formed soils will probably differ greatly. Further, soils formed in countries of similar climatic conditions, though the countries may be on opposite sides of the earth, are likely to have many properties in common.

The Climato-Geological Classification in Outline.

"The soils of the earth may be grouped into two great divisions which are defined according to the prevailing climatic conditions as Dry or Arid soils and Moist or Humid soils"*

The great distinction between these two main groups will be that Arid soils retain a large proportion of soluble material while in the Humid soils the soluble material has been largely removed by leaching.

Arid soils usually exhibit the features of sand even when they contain large amounts of clay. To the presence of this clay the frequently surprising fertility of irrigated desert sands is due. Such water movement as takes place in Arid soils is due to upward currents with a subsequent tendency for salt accumulations near the surface following on the evaporation of the water reaching the top soil.

Humid soils on the other hand are leached out almost entirely by downward currents of water so that tendency for accumulation is likely to be in strata well below the surface.

At first sight it would appear that there must be intermediate stages even of the main grouping but it is possible to place all soils within these main divisions. Soils which become frozen in winter will be little changed during this period, while during the summer months the soil change will be governed by the lack or excess of rainfall.

Soil Zones and Regions.

A distinction is made in sub-dividing soils as to whether their properties are due to a latitudinal significance in which case soil zones are spoken of, or a longitudinal significance in which case the term used is "soil region". In general Soil Zones are greater in extent than Soil Regions.

The Soil Zones and Regions are briefly grouped as follows:

A. The Cold Zones.
B. Cool Temperate Zones.
C. The Semi Arid Soils of temperate zones.
D. Saline or Alkali Soils.
E. Sub-Tropical Soils. (1) Sub-Tropical Red Earths, (2) Sub-Tropical Black Earths.

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* E. Rahmann. The evolution and Classification of Soils—English Edition page 49.

F. Tropical soils. (1) Humid soils, (2) Arid soils.

Consideration of space prevents discussion of the more detailed division of the above; a good detailed description and tabular classification of all known soils will be found in Rahmann's book.*

Soil Minerals.

Having discussed the general classification of soils a word must be said on the material of which they are composed.

The properties of a soil will depend to some extent on the actual minerals contained therein, their state of aggregation and the extent to which they are present.

The most important of these minerals are :— †

(*a*) Quartz.
(*b*) Mica.
(*c*) Iron (and Titanium) minerals.
(*d*) Felspars and Felspathoids.
(*e*) Amphiboles and Pyroxenes.
(*f*) Carbonates, Dolomites and Gypsum;
(*g*) Phosphorus containing minerals.
(*h*) Volcanic glasses.
(*i*) Secondary minerals.

The relative importance of these, considered merely as the proportion in which they occur in soils in various parts of the world, varies greatly.

(*a*) *Quartz.* Crystalline Silica or Silicon Dioxide is the most widely distributed soil mineral; this is not surprising when it is remembered that it is estimated that it constitutes something like forty per cent. of the earth's crust. It is crystalline, chemically inert and is the material of what is understood as the "sand of soil" is composed generally. Though chemically inert it nevertheless plays a most important part in soil economy; aeration, drainage and secondary weathering being largely dependent on the extent to which it is present in a coarse or fine state.

(*b*) *Mica.* A widely distributed soil mineral; it does not occur to a fraction of the extent of Quartz. It is readily recognisable, as it occurs in small plates and is the mineral which gives the sparkling appearance to Malayan river sand. It may occur in two forms as white mica or muscovite (the commoner form) or as black mica or biotite. Chemically mica is a postassium aluminium silicate.

(*c*) *Iron and Titanium Minerals* are also widely distributed particularly in the wet tropics and like quartz they are chemically inert but have a great effect on the physical composition of soil; iron is responsible for the red mottling of the sand while titanium minerals generally appear as black sand particles. This is further discussed under secondary minerals.

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* See foot-note on page 349.

† The order given is that of their likelihood of occurrence in Malayan soils and not soils in general.

(*d*) *Felspars and Felspathoids* are said to occur in all soils but in the tropics it frequently requires the eye of faith to discover them in an unchanged state. They are of great importance as they consist of potassium and sodium aluminium silicates and are hence sources of the essential mineral plant nutrient Potassium. This element occurs in the felspars between the limits 7 and 17 per cent. with an average near 12 per cent. Calcium and Magnesium are likely to be present in felspars but their amount is very small indeed.

(*e*) *Amphiboles and Pyroxenes* of which common hornblende and augite are the most important. They are essentially calcium magnesium silicates and hence are sources of two more essential elements of plant life, Calcium and Magnesium. Although they can be found in most soils in this country they form a very small percentage thereof but are still important for the reasons stated.

(*f*) *Carbonates, Dolomites and Gypsums.* Carbonates may occur as compounds of many metals but as far as the soil is concerned it is as calcium carbonate or dolomite (a magnesium calcium carbonate) that they are important. Gypsum is a calcium sulphate and is frequently a source of infertility in tropical soils. Gypsum may be regarded as totally absent from local soils while dolomites and carbonates are only likely to occur in certain very restricted and localised areas.

(*g*) *Phosphate bearing minerals.* Almost the entire phosphate content of a soil has its source in the mineral Apatite or Calcium Phosphate though it rarely appears in soil as such, especially in tropical soil where fierce weathering quickly decomposes the apatite, leaving the phosphate to be "adsorbed" by the clay of the soil. Almost all the minerals mentioned above however are subject to Apatite inclusions, and, although the amount of these inclusions are very small, they are the source of replenishment of the soil phosphate.

(*h*) *Volcanic glasses* are, as their name implies, minerals having no crystalline form but rather the appearance of glass; they are formed by very slow cooling during volcanic eruptions. In soil they actually have the appearance of minute splinters of glass or if they contain or have contained air bubbles they are readily recognisable under the form of pumice. These glasses contain a few per cent. of sodium, potassium, calcium and magnesium but being very resistant to weathering they can only be regarded as secondary sources of these essential elements. In this country they are only likely to occur in certain areas of Pahang and East Johore.

(*i*) *Secondary minerals.* Most important of these, particularly in the wet tropics, is alumina, which occurs as hydrargillite in laterites etc. Almost as important are oxides and hydroxides of iron on which the red or yellow colouration of tropical soils depends. The red colour of desert sands is due to an exterior coating of iron oxide over the quartz sand. Under this heading of secondary minerals may be placed gypsum and alkali carbonates, already mentioned above, to the former of which the infertility of much American

desert is due, while the latter forms the black alkali soils, one of the great problems of many tropical countries. These alkali soils must not however be confused with local black soils whose colour is due to an entirely different reason. In this country only alumina and oxides of iron are of any importance under this group.

The Formation of Soils.

Soils are formed in two ways, either as rock residues or as transported rock sediments.

They depend on the action of heat or cold, air and water.

(1) *Residual soils* or those formed in situ depend on the chemical and physical nature of the underlying parent rock, the temperature and moisture conditions (in arid lands on wind) and the extent to which, owing to fissures and overlying material, the rock is exposed. In the tropics elevated temperatures increase the solvent action of water and its dissolved gases oxygen, carbon dioxide and oxides of nitrogen. This is compensated for, to some extent, in temperate climates subject to frost, by the physical disintegration which occurs owing to water freezing in crevices, thus giving a continually larger surface of exposure after each frost. The solvent action of water is actually very small on hard igneous rocks but the action on the cementing material of sedimentary rocks* is frequently very rapid. It is to be expected therefore that soils formed in situ by the disintegration of the harder rocks are likely to be shallow, while those from the softer rocks are likely to be deep.

(2) *Transported soils* have in general no relation whatever to the underlying rocks, their generic relationships being with the rocks by whose disintegration they were formed. Owing to their mode of deposition transported soils frequently resemble each other, even when derived from totally different parent material. It must not be assumed however that over really wide areas these redeposited soils have identical properties, it is rather that where their environment is similar the soils will be similar irrespective of their parent material. In general they are likely to contain much fine material and much more plant nutrients than residual soils for they are formed of the material leached out and eroded from the rock by the action of water and carried by streams and rivers to some lower level where they build up flat unbroken plains.

The soil as a source and reservoir of plant food and a medium for plant growth.

The above has taken into consideration chiefly the foundation of a scientific classification but from the husbandman's point of view mention must be made of certain chemical elements as essential plant foods. These consist of potassium, magnesium, calcium, nitrogen and phosphorus and to a minor degree

* In the new Klang Road cutting at Kuala Lumpur the formation of soil from rocks of the quartzite and shale series is visible after a few months exposure.

iron and minute quantities of many others all of which are essential but whose total quantity is so small that there is little likelihood of any shortage due to exhaustion. On the other hand the economies of the first five mentioned play a most important part in the plant cycle. As far as phosphorus is concerned it is regarded at present as the limiting factor of our world, a position occupied by nitrogen in the last century. The nitrogen problem has been satisfactorily solved so that in spite of its present position it is possible that some process will be invented for the recovery of phosphates (from the sea for example).

Soil consists in the aggregate of particles ranging from 'stones' to particles so fine as to be only visible with a powerful microscope, from 'sand' to 'clay'. The finer portions of a soil are often spoken of as soil colloids, a colloid being regarded as midway between a suspension and a true solution. The formation of colloids or sands depends largely on the composition of the parent material. Quartz crystals present in the original rock as such are subsequently found in the soil as such. The clay or colloid is formed by the decomposition of complex aluminium silicates such as felspar mentioned above. On weathering these complex silicates break down, losing their more soluble potash, soda, etc., leaving behind aluminium silicates or clay. It is the portion of the soil which does not settle readily in water and for this reason is liable to be carried off in stream water (in which case it will be subsequently deposited as an alluvium). The important thing about the colloid as at present being discussed is that it has the property of "adsorbing" into itself many mineral and organic salts, that is to say it retains these salts with a definite force against the action of leaching water. This does not mean that water has no leaching action in removing salts from the soil but that its effect is considerably slowed down by this competitive action of the colloid. All the potash, magnesium etc. retained by the soil in a form immediately assimilable by plants is retained by adsorption. In addition to this adsorptive capacity for salts the water retaining capacity of a soil depends almost entirely on the amount of the colloid. Soil aeration on the other hand will depend on the presence of sand and gravel.

The picture therefore is of sand and gravel and colloid forming a homogeneous mixture-soil; a slow leaching out of salts absorbed by the colloid and a slow replacement by the weathering of the mineral particles mentioned under the headnig of soil minerals. The phrase homogeneous mixture is only partly true for there are nearly always variations with depth. The section of a soil from the surface to the rock face beneath is known as "a soil profile".

Usually the soil at the surface and for a depth of six inches or so is darker in colour than that at greater depths, due to the presence of organic matter. The change to the lighter colour may be imperceptably gradual or it may be sharply defined or in this country it frequently happens that there is no visible change, the organic content being small and not deeply coloured,

At a lower depth there may be an accumulation of some mineral compounds which may show as a band or there may be a layer which has been leached. These various bands down the profile are known as horizons. In this country they are often absent, the only two distinctions it is possible to make in such cases being soil and rock.

Two soils are of especial interest in this connection, the Podsols and Laterites.

The former which do not occur in this country have a surface layer from which the iron and alumina has been largely leached leaving a preponderance of silica. Beneath is a "pan" consisting of soil which has been cemented together by humus leached from above.

The laterites are generally considered as soil from which the silica has been leached leaving iron and alumina. Local observations shew, however, that laterite can be formed by the leaching of iron and alumina from a top soil with subsequent accumulation of iron and alumina at a lower level.

The texture of a soil depends on a number of factors, on the amount of sand, silt and clay and the ratios between them, *i.e.* (its mechanical composition) and also on the state of aggregation. Small particles are frequently cemented together to form a larger particle, this, as far as aeration, drainage etc. goes, having the properties of the larger particle. This type of aggregation is spoken of as 'crumb structure'. In soils possessing this crumb structure ordinary mechanical analysis is often deceptive as the crumb is broken down during the analysis into smaller components and the soil is returned as much heavier than it actually is.

The function of soil analysis may be to classify soils in the general scheme or more generally to enable the husbandman, by reference to a series of defined standards, to ascertain the nature and requirements of his soil. Analysis falls under three heads: mechanical, chemical, mineralogical. The first of these divides the soil into a number of fractions between certain limits of size, gravel, sand, fine-sand, silt, clay. From the figures obtained it is possible to get some idea of a soil "lightness", "heaviness", drainage capabilities etc.

It is only an approximation for there will be a continual variation of particle size within any given limits; a fact which ordinary mechanical analysis does not shew. It takes no account of the aggregation or crumb structure mentioned above.

Chemical analysis on the other hand aims at shewing the amounts of plant nutrients present in the soil both in respect of the total amount and the amount in a state to be immediately taken up by the plant. The former is usually spoken of as the "total" the latter as the "available".

Mineralogical analysis on the other hand is concerned with the minerals in the soil, in their original state, a state in which they will not be likely to appear under the heading of "total" or "available". It is concerned with the ultimate as opposed to the immediate food reserves of the soil.

B. MALAYAN SOILS AND CONDITIONS.

In the foregoing, soils have been discussed in general terms with practically no reference to Malayan conditions.

Malaya as a whole may be regarded as monoclimatic in spite of certain minor differences on the east side of the peninsula and it therefore seems a reasonable hypothesis to work on, that, within Malaya, soil differences might be a function of the geology.

In order to test this hypothesis a soil survey over a limited area was carried out a few years ago and the results were published in the *Malayan Agricultural Journal*, July, 1929. This survey was extended at a later date to the coastal areas. This was published in the *Malayan Agricultural Journal*, June, 1932. In the first survey it was clearly established that definite distinctions between soils were associated with geological formations and that for broad purposes it appeared possible to use the geological map as a basis. The great advantage of this lies in the fact that the Geological Survey is in an advanced state. Since then something more than a thousand soils have been examined from various parts of the Peninsula and the distinctions made in this first survey have been found to hold, even for transported soils in valley, since, in general, transport has only been effected from closely adjacent hills.*

The survey of the coastal areas however did not enable distinctions of a similar nature to be made. All these latter are transported soils with large general resemblances irrespective of geological origin, distinctions being mostly due to very localised conditions.

The surveys mentioned above distinguished three main inland groups and one coastal group :

(A)	The Granite Soils.	
(B)	The Quartzite Soils.	(i) Hill Soils,
		(ii) Valley.
(C)	The Raub Soils.	(i) High level,
		(ii) Low level.
(D)	Coastal Alluvium.	(i) Coastal clay,
		(ii) Peat,
		(iii) Organic Soils.

Since these distinctions were made, examination has been made of two rather localised types.

(E) Pahang Volcanic.
(F) Dolorite.
(G) Highland Soils.

The distinctive features of the first four groups have already been published in detail and are again briefly summarised below :

* An exception is Raub low level soils discussed below.

(A) *Granite Soils.* Light coloured, well drained and containing almost equal proportions of clay and sand. No definite distinction is made of low level granite soils, but where such soils do occur in broad valleys there is an increase in the silt and clay. In narrow gorges this is reversed and there is a large decrease in the latter owing to the scouring action of stream water.

(B) *The Quartzites.* (i) Hill Soils generally have a low percentage of coarse sand and this tends to close packing down helped by rather complete absence of crumb structure. They show considerable variation in proportion of fine sand, silt and clay at times shew a narrow band of laterite an inch or two in thickness at about eighteen inches below the surface. This band, however, is too thin to have any effect agriculturally.

(ii) Valley soils are extremely variable and frequently shew such undesirable features as carbonaceous shales which, in the limit, result in soils with a high percentage of free carbon, which are almost completely sterile. Iron sulphide is sometimes present which on opening up is oxidised with the formation of free sulphuric acid leading to disastrous effects on vegetation.

(C) *Raub Series Soils* (i) High level soils appear largely derived from phyllites.* though the other contemporaneous rocks appear to give this type of soil. They are characterised by the occurrence of a layer of laterite (in the popular sense) often sufficiently thick to interfere with sampling and agriculture generally, at a depth of some eighteen to thirty inches. The soils are usually of a deep red colour and have a good crumb structure; hence they contain much more clay than their texture leads one to suppose.

(ii) Low level soils are not usually connected with the underlying rock but are really a recent inland alluvium overlying (generally) a limestone floor. It is however convenient to group them with the Raub series as they always occur overlying rocks of this age. They are usually whitish yellow in colour with a fairly open texture and indifferent agricultural properties.

(D) *Coastal Alluvium.* (i) Coastal clays; under undrained conditions the surface soil is of a grey colour changing to blue or blue green at the permanent water table. On draining they present a mottled appearance. Shallow peat layers are frequent. Sulphur compounds are of common occurrence.

(ii) Peat needs little explanation, it generally lies contiguous to the inland quartzite soils.

(iii) Organic soils have properties midway between those of peat and clay. The coastal alluvium can be regarded as the richest soil in Malaya but owing to heavy texture its drainage is restricted.

(E) and (F) Both the Pahang Volcanic soils and the Dolorite soils occur chiefly in Pahang. The former appear to be richer in total potash than usual while the Dolorite soils shew unusual texture and are remarkable for the large quantity of phosphates they contain. Their area is very restricted however.

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* *Phyllites.* So called from their tendency to split in planes. They are argillaceous rocks.

(G) *Highland Soils* are generally granites and are very immature. Chemically they are somewhat richer in nutrients and have larger amounts of decaying vegetable material on the surface than the corresponding soils of the plains but they are essentially the same.

Texture and Drainage.

Mention has been made above of texture and drainage. Nearly all Malayan inland soils are of open texture and are, in consequence, very free draining. Even in the case of the quartzites which tend to 'pack' there is a good water movement. This, with Malaya's heavy rainfall, tends to intensify leaching and, on steep slopes, may cause all the effect of drought when the soil is exceptionally sandy owing to the rapid penetration and run off. In a case at the Forest Research Station at Kepong quite good growth was obtained on the flat top of a hill where all the original top soil has been removed, while on the steep slopes growth was incredibly bad. Heavy manuring with cattle manure had no effect and the trouble was eventually traced to the lack of water retentive power on the steep slopes.

In this connection also is the growing conviction among planters that oil palms will not give as high yields on hills as on gently undulating to flat land.

On flat land the problem, particularly with coastal alluvial soils (the major portion of flat land), is reserved and much depends on getting sufficient drainage for successful agricultural operations.

This problem is considerable and a number of investigations in connection with it have been started. Artificial soils made up in the laboratory at first proved to be as freely draining as the inland soils but after some months they gradually settled and compacted until now after a period of eighteen months drainage is extremely small. It would appear likely that much drainage of these coastal clays is made possible by the action of roots and worms which form drainage channels and, in the case of freshly drained land, to the action of crabs. On the other hand on well drained land at the Klang Coconut Station a carefully prepared profile shewed little signs of root and worms below about 18 to 24 inches.

Drainage and observation on a bigger scale have been started at the above Station, observations being made on the drainage levels at different tide phases and in connection with incidence of rainfall.

Further laboratory observations have shewn that there are great differences in the drainage rates of coastal soils under the same conditions of temperature and composition.

Much has been written about the addition of organic matter lightening the texture of a soil and so effecting drainage. This cannot be said to hold at all in Malaya except in the case of peats.

Peats have already been mentioned above in connection with general remarks on coastal alluvials. In addition to these coastal peats, however, there are hill peats (not the hoch-moor peats of temperate climates but those bearing a close relationship with those of the plains). With hill peat, preservation is largely due to the lower temperatures experienced; with coastal peats, on the other hand, preservation has been largely due to the fact that they were water logged. Two types can be recognised: an acid peat and one with an almost neutral reaction. The acidity of the former is very high (up to pH 1.5) and appears to be probably due to partial drying out of peats containing sulphur compounds. During the drying out phases these sulphur compounds are oxidised to free sulphuric acid with subsequent ill effects on vegetation.

Too rapid draining of peat areas is frequently disastrous as there is a rapid shrinking to a dry powder, (which is then subject to considerable oxidation) which it is almost impossible to recondition.

Inland Soils.

In considering the actual composition of Malayan soils it is well to bear in mind that, in spite of the "luxurious tropical vegetation", with which they are frequently covered, they cannot be considered as highly fertile. Soils having the properties of Malayan soils would be rejected as worthless in Western Europe. Intense leaching keeps the amount of available plant food at a minimum, and it is only because intense leaching is accompanied by intense weathering of the small amounts of plant foods which are in combination as complex minerals, that local soils have some semblance of fertility.

The so called "total" mineral plant foods cannot be regarded as at all high with one or two exceptions. Figures are given in the table below:

	Lime (CaO) per cent.	Potash (K_2O) per cent.	Phosphates (P_2O_5) per cent.
Quartzite ...	up to 0.05	0.10	up to 0.02
Granite ...	up to 0.04	0.05	0.02
Raub (High) ...	up to 0.03	0.50	0.03
Coastal (heavier) ...	0.13	0.80	0.04
Coastal (lighter) ...	0.02	0.20	0.02
Pahang Volcanic ...	0.04	0.70	0.06
Dolorite ...	0.05	0.30	1.00

The "available" plant food, *i.e.* that contained in the colloid complex as simple salts in a form readily assimilable by the plant is not more than a tenth of these figures.

The variation of both "total" and "available" mineral nutrients with depth is likely to vary with the particular soil concerned. A soil of the quartzite series formed from soft rock tends to shew an evenness of chemical analysis over a considerable depth. On the other hand a soil of the granite series being formed

from a harder rock tends to shew an amount of deterioration (in the sense of availability) with depth. This is because the rock complex is less easily broken down and hence the biggest changes are at the point of maximum attack by weather.

The Raub high level series represent yet a different mode of weathering. There are definite layers of accumulation and/or leaching. The effect of the intense climatic conditions has been to accumulate a ferruginous layer at some thirty inches below the surface or again the intense leaching may have the effect of removing much of the silica in solution leaving a high concentration of iron and alumina.

Soil Bases and Acidity.

Much is written of soil "bases" now-a-days. By this term is meant the Calcium, Lime, Potash, Magnesia and Soda which the soil contains in simple combination; not as complex components of soil fragments. Base and alkali are roughly the same in chemical parlance and are regarded as the antithesis of acid. Soil acidity has a different significance in the tropics compared with temperate climates. The standard of acidity almost universally accepted to-day is the pH scale; a soil of about pH 7.5 has a neutral action, one with a higher figure than this will be alkaline, with a lower figure acid. Further this scale is logarithmic *i.e.* each progressive change of 1.0 meaning a tenfold increase or decrease in acidity or alkalinity. Most inland Malayan soils have pH values of 4.5—5.5 apparently well on the acid side. The simplest way is to regard them as acid but not sour, the difference being possibly well expressed by the Malay word "assam" as opposed to "busok". Again in this connection the lime requirement, as estimated by methods consistent with agricultural practice in Europe, shews, in parallel with the pH figures, values up to 20 tons per acre, a figure which is quite prohibitive in cost in the first place and in the event of such an application, may result in permanent impoverishment, the lime turning out the other "bases" essential to plant growth. The explanation of the harmlessness of the acidity of the average Malayan soil would appear to be rather as follows.

The acidity may be regarded as in two parts, (i) the soluble part and (ii) the insoluble part. The soluble part is that contained in the soil solution. It is with this portion that the plant is concerned. The concentration of this soluble portion is small. The insoluble part is intimately attached to the envelope of the soil particle and does not directly affect the plant. The insoluble portion has the greater effect on pH and lime requirement measurements. In this connection must be mentioned the buffer action of soils, most simply defined as the resistance of soils to changes of pH (*i.e.* of acidity or alkalinity) on the addition of acids or alkalies. This has some considerable importance in connection with manurial programmes for if a soil is but poorly buffered the

addition of (say) Ammonium sulphate (a physiologically acid manure) will tend to make the soil more acid so that it may therefore be necessary to add lime to neutralise this effect. If on the other hand a soil is highly buffered this addition of lime is unnecessary. This is a point which is not too fully recognised locally.

There are occasional instances where the soil acidity is definitely harmful; frequently in such cases the pH is 3.5 or less and there is usually in such instances a high concentration of acid in the soil solution. This is generally present as free Sulphuric acid, formed frequently where there are old nipah stumps and similar vegetation, containing amounts of sulphur compounds which are subsequently oxidised, (when the stumps are killed), to sulphuric acid. This type of acidity nearly always occurs on coastal alluvials. Occasional examples of a similar nature have been found on quartzite valley areas. The cause appears to be similar though in this case it is likely that the sulphur before oxidation, is present as pyrites.

Malayan and Other Soils.

How do Malayan soils compare with those of other tropical countries and those of temperate climates?

It must be constantly borne in mind that Malayan soils are mature* and that they have undergone and are undergoing continuous intense leaching. They have little chance of any recuperation in the sense of lying fallow, with the exception of rice areas, and, unlike many parts of the tropics, they have no source of renewal from volcanic ashes. There is a continual replenishment of soil in some countries from this source. In temperate climes such volcanic dust is regarded as infertile but under intense tropical conditions there is a rapid break down to the state where its contained minerals are in an available form. In Sumatra, conditions are much more closely ailled to those of Malaya; Java on the other hand is largely actively volcanic and is therefore much more fertile. Many parts of West Africa have similar climatic conditions to Malaya and the soils from all accounts appear similar though not necessarily so mature.

As has been stated above, compared with temperate countries, the soils of Malaya must be regarded as poor. Practically all the inland soils would be looked on with contempt by the average European or American farmer, for Malayan soils as they are now, if transported to cooler climates, would prove extremely barren. They depend for their alleged fertility on optimum conditions, as far as temperature and rain goes, for plant growth, and on the intensive weathering always rendering small amounts of plant food available in our local soil.

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* Mature is here used in contradistinction to young or freshly formed soils. They are in an advanced stage of weathering and shew little tendency towards change.

Organic Matter and Nitrogen.

Much has been said above about mineral plant foods but little has been said about the essential nitrogen and the role of organic matter in soil.

Organic matter comprises all the decaying vegetable and animal material contained in the soil. It is not synonymous with "humus". Humus is organic matter in a definite and more simplified state. It is the organic matter which has been broken down to the extent that it can enter into loose combination with soil bases etc. and into a loose combination with the colloid complex. When the soil is normal the ratio of the total nitrogen to the total carbon (themselves rough measures of organic matter) is about 11.0. Many quartzite valley soils shew a figure greatly in excess of this due largely to the presence of free carbon.

The nitrogen in the soil is continually changing *i.e.* it is dynamic but if measured by analysis over long periods practically no difference would be found year by year, for each portion of nitrogen converted to the form of say nitrate is largely replaced by fresh organic matter entering the soil from decaying vegetable material.

Nitrogen is present in many forms in the soil; as gaseous nitrogen in the soil air, in combination in organic matter, as nitrate, as ammonia and as nitrites. There is a constant change between all these different states, organic nitrogen being converted to ammonia and subsequently oxidised to nitrates. Nitrates are reduced under flooded conditions to nitrite and ammonia, the reverse happening when the soil dries out again. But in spite of all these changes the picture is static. The nitrogen content of individual inland soils tends to shew stationary figures for total nitrogen for nitrates and for ammonia. On coastal soils subject to flooding and on rice soils there will be a change from nitrates to ammonia when flooded and from ammonia to nitrates when wet.

The nitrogen content of inland soils is from 0.1 to 0.2 per cent. and of coastal soil from 0.15 to 0.4 per cent. A detailed discussion of nitrogen will be given in the third paper of this series.

RESULTS ON STEM BORER EXPERIMENTS IN KRIAN DURING THE 1931 - 1932 PADI SEASON

Compiled By
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from
The Records Obtained,
by
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Introduction.

This report is based on the records left by Mr. H. T. Pagden, formerly Assistant Entomologist, to whom full credit must be given for all these records, since he was responsible for recording the data and for supervising the investigation of padi borers in the field.

The writer would like to place on record his appreciation of the work which Mr. Pagden has performed in endeavouring to obtain information for the control of padi borers during the past two years.

Experiments.

Four experiments were laid down for the 1931—32 padi season at the following places in Krian:—Bagan Tiang (Swee Lee Estate), Titi Serong Experimental Station and 12th mile Bagan Serai.

Experiment I - Yields.

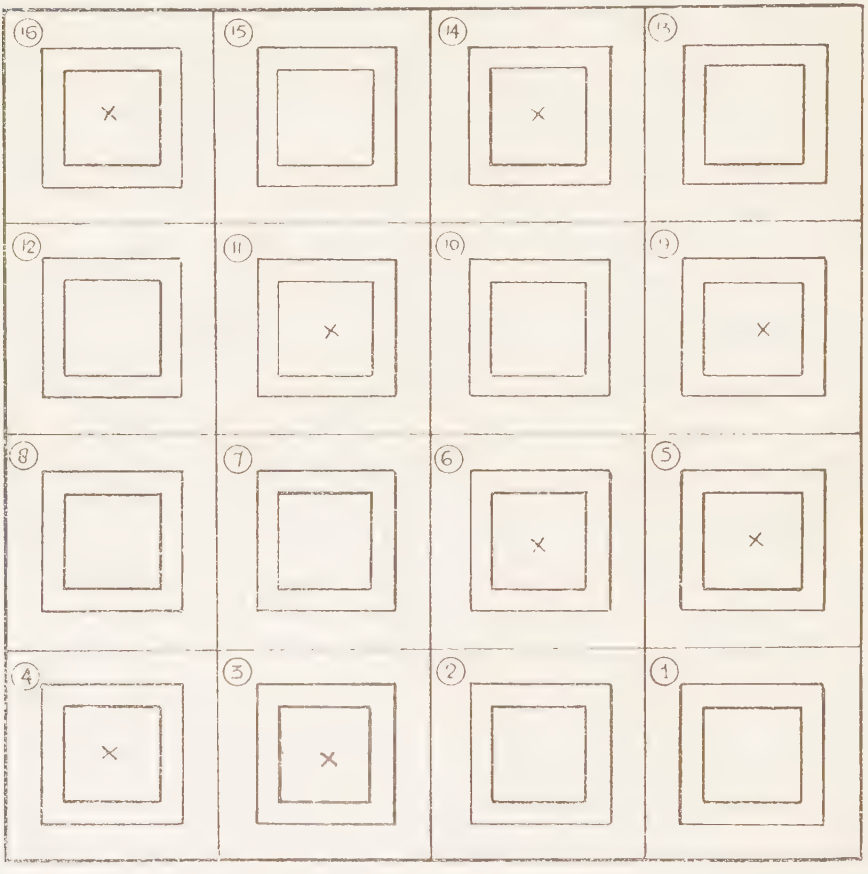
This experiment was for the purpose of comparing yields from non-colonised areas and areas colonised with the parasite, *Trichogramma minutum.*

This area of 16 acres was situated on Swee Lee Estate, Mukim of Bagan Tiang. It was sub-divided into one acre blocks. In the centre of each acre a 1/10 acre plot was measured and over 8 of these 1/10 acre plots parasites were liberated at the rate of 20,000 per tenth acre. In the middle of each 1/10 acre plot a 1/40 acre plot was reserved for the purpose of calculating yields: stem counts were made from all 16 plots.

The type of padi used in this area was Seraup kechil 36. Seeds were sown on July 12th, 1931. The first transplanting was carried out on July 21st and the second on July 25th, 1931. The planting of the 16 acres commenced on September 28th and was completed on October 4th, 1931. The 1/40 acre plots were planted with 432 plants—a spacing of 18 inches.

No egg masses of stem-borer moths were collected from these plots.

Diagram illustrating the arrangement of the plots in Experiment I.



Trichogramma was liberated over the plots marked x.

Liberation of Parasites:—The liberation of parasites commenced on December 3rd, 1931, in Plot 14 and ceased on December 18th, 1931, in Plot 11. Eight Plots, Nos. 3, 4, 5, 6, 9, 11, 14 and 16, were colonised and two circuits of liberations were made, 20,000 parasites being liberated in each 1/10 acre, equivalent to 200,000 per acre.

Stem Counts:—Stem counts were made from 1/10 acre plots. The work was commenced on January 25th. Twenty plants were taken from each 1/10 acre plot in one day, making altogether 320 plants from this area. Counting was commenced on January 26th and was completed on February 13th. The following figures show the result of the count from colonised and uncolonised areas:—

No. of tillers.	Colonised Area.			
	No. of tillers attacked.	Total No. of *Diatraea*, larvae and pupae found.	Total No. of *Sesamia*, larvae and pupae found.	Total No. of *Schoenobius* larvae and pupae found.
1839	1358 = 73.84 per cent.	395 larvae, 19 pupae	5 larvae	30 larvae
		Uncolonised Area.		
1804	1393 = 77.21 per cent.	816 larvae, 9 pupae	1 larvae	60 larvae 4 pupae

A very slight decrease in the percentage of attacked tillers in the Colonised Area is revealed and more larvae of *Diatraea* and *Schoenobuis* were formed in the Uncolonised than in the Colonised area.

Harvesting:—Harvesting of the 1/40 acre plots was commenced on February 22nd and was completed on February 25th.

The results are summarised thus:—

Plots receiving parasites:—493 plants (3456 planted) yielded about 3.5 gantangs of padi = 0.11 paus per plant.

Plots not receiving parasites:—484 plants (3456 planted) yielded 3.6 gantangs of padi = 0.12 paus per plant.

Out of 3456 plants planted only 493 in the Colonised area and 484 in the Uncolonised area remained. A considerable amount of rat damage occurred and this was followed by the growth of grasses and "menderong" which caused the padi to die. The plants harvested were alive but their appearance was very poor.

Experiment II - Natural and Induced Parasitism.

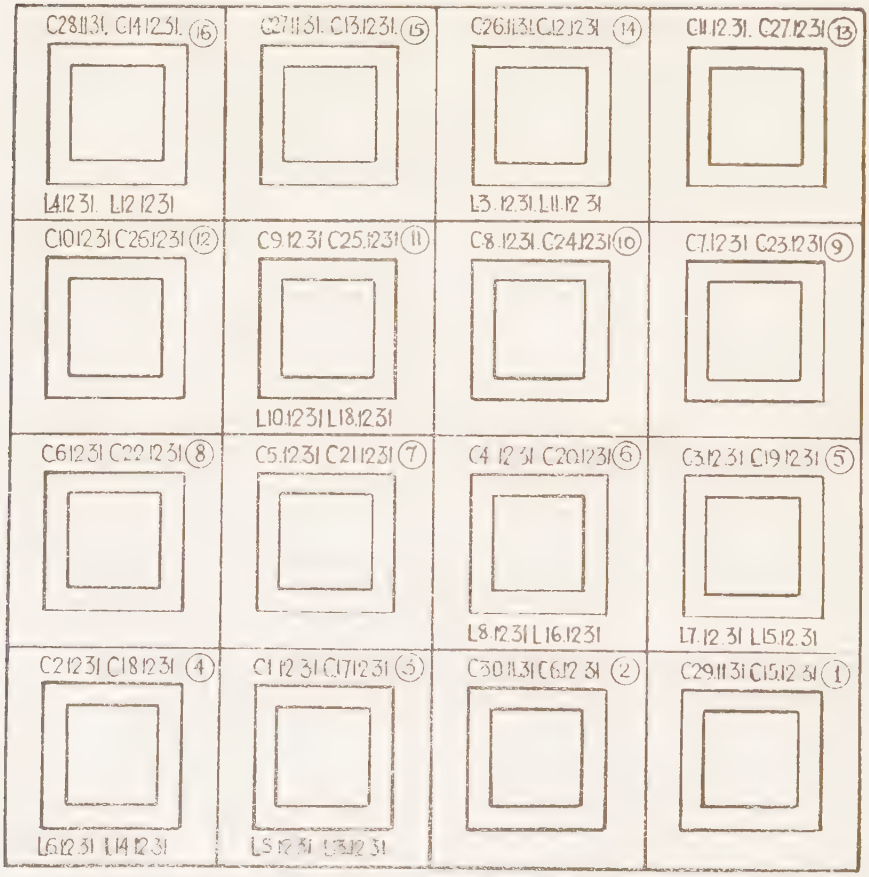
This area was situated adjacent to the area selected at Swee Lee Estate for Experiment I and the lay-out of this Experiment was similar to that described in Experiment No. 1. On eight 1/10 acre plots *Trichogramma* was liberated and coolies were employed to collect egg masses of stem borer moths from all the sixteen plots.

Seeds were sown on July 11th, 1931. The first transplanting was carried out on July 20th and the second on July 24th, 1931. Planting was commenced on September 22nd and was completed on October 10th, 1931.

Collection of Egg Masses:—Collection of egg masses was started on October 12th in Plot No. 1 and ceased on December 27th in Plot 13. The collection was discontinued when the padi was about to flower.

Egg masses of *Diatraea* were first collected on October 29th in Plot 2. *Schoenobius* first occurred on October 23rd in Plot 12. It is interesting to note that, although *Chilo* egg masses were collected in this area, they were not obtained in two other areas where egg collecting was carried out. *Chilo* egg masses were usually found on "menderong" (*Scirpus grossus*). *Diatraea* egg masses appeared to increase in December, the highest number collected in one day being 95 in Plot 15 on December 13th. *Schoenobius* remained more or less constant, the highest number being 24, collected from Plot 9 on December 23rd. The first *Chilo* egg mass was collected in Plot 7 on October 18th. The largest number collected on one occasion was ten.

Diagram illustrating the arrangement of the plots in Experiment II.



C = Dates of collection of egg masses.
L = Dates of liberation of parasites.

Liberation of Parasites:—Liberation of parasites commenced on December 3rd., 1931, in Plot 14 and ceased on December 18th. in Plot 11. The liberation was so arranged to avoid liberations and collections in the same plot on the same day. The collection of ova continued until December 27th., so that egg masses from each plot were collected once after the liberation of parasites. Eight plots, Nos. 3, 4, 5, 6, 9, 11, 14 and 16, were colonised and two circuits of liberations were made, 20,000 parasites being liberated altogether in each 1/10 acre plot equivalent to 200,000 per acre.

The results are tabulated herewith;

(1) Parasitism of Diatraea Egg Masses.

	Colonised Plots.		Uncolonised Plots.	
Plot No.	Percentage of Parasitism before liberation.	Percentage of Parasitism after liberation.	Percentage of Parasitism during first circuit.	Percentage of Parasitism during second circuit.
1			21.4	44
2			11.7	33.3
3	0	26.4		
4	40	46.4		
5	5.34	36.5		
6	45	50		
7			32.2	41
8			50	73
9	37	42.5		
10			46.8	65.7
11	61.7	73		
12			81.5	62.2
13			17.7	43.2
14	20	35.7		
15			30	50.5
16	20	25		

Colonised Area:—In the circuit immediately prior to the liberation of parasites, 192 egg masses, of which 78 were parasitised, *i.e.* 40.6 per cent. parasitism, were collected from those plots intended for colonisation. After the liberation of *Trichogramma* 397 egg masses were collected from the colonised plots of which 158 were parasitised, a percentage of 39.8. This result indicates that the percentage parasitism was not increased by the introduction of parasites.

Uncolonised Area:—In the first circuit 304 egg masses were collected of which 142 were parasitised, giving a percentage parasitism of 46.7. In the second circuit 371 egg masses were collected of which 198 were parasitised, a percentage of 53.4.

The above figures show that an increase of about 7 per cent. in natural parasitism occurred during the interval between the first and second circuits in the uncolonised plots. This, however, was not recorded in the plots which received parasites.

(2) Parasitism of Schoenobius Egg Masses.

Colonised Plots.			Uncolonised Plots.	
Plot No.	Percentage of Parasitism by *Trichogramma* before liberation.	Percentage of Parasitism by *Trichogramma* after liberation.	Percentage of Parasitism by *Trichogramma* during first circuit.	Percentage of Parasitism by *Trichogramma* during the second circuit.
1			33.3	76.9
2			50	38.4
3	0	71.4		
4	100	63.6		
5	0	64.2		
6	0	100		
7			100	94.1
8			0	100
9	44.4	66.6		
10			75.0	66.6
11	100	61.5		
12			80	100
13			18.1	61
14	0	85.7		
15			100	100
16	0	80		

Colonised Plots:—Before liberation 22 egg masses were collected of which 9 were parasitised by *Trichogramma* giving a percentage parasitism of 40.9. After the liberation of parasites, 86 egg masses were collected of which 60 were parasitised by *Trichogramma*, a percentage of 69.8. This result indicates that the parasitism increased by 29. This, however, may be due to an increase in natural and not to induced parasitism (see below).

Uncolonised Plots:—During the first circuit 44 egg masses were collected of which 27 were parasitised by *Trichogramma*, giving a percentage parasitism of 61.4.

During the second circuit 101 egg masses were collected of which 74 were parasitised by *Trichogramma*, a percentage of 73.3. The natural parasitism would appear to have increased by about 12 per cent. indicating that the liberation of parasites was responsible for 17 per cent. of *Schoenobius* egg masses being parasitised.

(3) Parasitism of Chilo Egg Masses.

The number of *Chilo* egg masses collected from all 16 plots was 68. Only one and that from the Uncolonised area was parasitised by *Trichogramma*. This result indicates that *Trichogramma* is not an active parasite of *Chilo*. *Phanurus* emerged from 33 egg masses—a percentage of 48.5.

The following figures are the records of egg collections made during the period October 12th, 1931 to December 27th, 1931, from the Colonised and Uncolonised plots.

Diatraea.

Colonised Plots.	Uncolonised Plots.
Total No. of egg masses 664	Total No. of egg masses 748
Total No. of masses with *Trichogramma*, 256 = 38.6 per cent.	Total No. of masses with *Trichogramma*, 377 = 50 per cent.
Total No. of masses with 50 per cent. parasitism or over 193 = 29.1 per cent.	Total No. of masses with 50 per cent. parasitism or over 275 = 36.8 per cent.

Schoenobius.

Colonised Plots.	Uncolonised Plots.
Total No. of masses 120	Total No. of masses 166
Total No. of masses with parasites 82 = 68.3 per cent.	Total No. of masses with parasites 114 = 68.7 per cent.
Total No. with *Trichogramma* 69 = 57.5 per cent.	Total No. with *Trichogramma* 98 = 59 per cent.
Total No. with *Phanurus* 8 = 6.7 per cent.	Total No. with *Phanurus* 5 = 3 per cent.
Total No. mixed with *Trichogramma* and *Phanurus* 5 = 4.2 per cent.	Total No. mixed with *Trichogramma* and *Phanurus* 11 = 6.6 per cent.

The liberation of *Trichogramma* over the Colonised Plots commenced on December 3rd and continued until December 18th so that these figures cannot be said to reveal the difference between the Colonised and the Uncolonised areas since the collection of egg masses was done only once after the liberation of *Trichogramma*.

Stem Counts:—Stem counts were made from all 1/10 acre plots. The work was commenced on January 20th. Twenty plants were taken from each 1/10 acre plot on one day, making altogether 320 plants from this area. Counting was commenced on January 26th and was completed on February 13th. The following figures show the results of the counts of stems from the Colonised and Uncolonised areas.

Colonised Area.		Uncolonised Area.	
No. of tillers	2368	No. of tillers	2508
No. of tillers bored 1687 = 71.2 per cent.		No. of tillers bored 1693 = 67.50 per cent.	
No. of *Diatraea* larvae	586	No. of *Diatraea* larvae	663
No. of *Diatraea* pupae	25	No. of *Diatraea* pupae	9
No. of *Sesamia* larvae	9	No. of *Sesamia* larvae	7
No. of *Sesamia* pupae	Nil	No. of *Semasia* pupae	Nil
No. of *Schoenobius* larvae	29	No. of *Schoenobius* larvae	36
No. of *Schoenobius* pupae	1	No. of *Schoenobius* pupae	2

This result shows a greater percentage of bored tillers in the Colonised than in the Uncolonised area.

Harvesting:—Harvesting of the 1/40 acre plots was started on February 14th, 1932, in Plots Nos. 13 and 14 and was completed on February 20th, 1932.

The yields from plants in the Colonised and Uncolonised plots were as follows:—

Colonised Area.					Uncolonised Area.				
Plot No.	Yield.				Plot No.	Yield			
	Gantang	Chupak	Paus	No. of plants		Gantang	Chupak	Paus	No. of plants
3	5	1	1	374	1	6	2	1	408
4	3	3	0	399	2	6	0	3	413
5	2	1	1	365	7	4	1	2	360
6	1	3	1	375	8	1	3	0	381
9	2	2	2	370	10	1	3	3	363
11	0	3	0	182	12	0	3	0	313
14	2	0	2	360	13	3	2	3	362
16	3	2	0	369	15	3	3	0	384
	22	0	3	2,794		29	0	0	2,984

Plots receiving parasites:—2794 plants (3456 planted) yielded about 22 gantangs of padi = 0.13 paus per plant.

Plots not receiving parasites:—2984 plants (3456 planted) yielded 29 gantangs of padi = 0.16 paus per plant. This result shows a lower yield from those plots over which parasites were liberated.

It will be seen that out of 3456 plants planted only 2794 and 2984 remained in the colonised and uncolonised plots respectively. A considerable amount of rat damage occurred which was followed by the appearance of grasses and 'menderong' causing the padi to die.

Experiment III - Seasonal Occurrence of Borers.

The purpose of this experiment was to ascertain whether stem borers were seasonal. Last season's work indicated that irrespective of the condition of padi, stem borers may be seasonal.

Schoenobius became numerous in late December, 1930, *Diatraea* in January, 1931, when collection ceased.

Two 1/6 acre plots were reserved, one at Swee Lee Estate and the other 13 miles away in a south easterly direction at 12th. mile, Bagan Serai. The type of padi used was Seraup Kechil 36 at Swee Lee Estate and Seraup Besar at Bagan Serai. It was intended to plant the same variety, but, since all the padi had been planted at Bagan Serai, there was no alternative but to select 1/6 acre which had been planted with Seraup Besar.

Five coolies were employed at each area for collecting egg masses until the padi plants died.

The collection of egg masses was commenced at both places on October 12th., 1931, and ceased on March 31st., 1932.

The figures below show the total number of egg-masses collected in each month.

Swee Lee Estate.			Bagan Serai.		
Period	*Diatraea*	*Schoenobius*	Period.	*Diatraea*	*Schoenobius*
October 31 ...	45	3	October 31 ...	42	103
November 31 ...	153	12	November 31 ...	507	563
December 31 ...	1,389	71	December 31 ...	570	279
January 32 ...	901	16	January 32 ...	285	101
February 32 ...	105	0	February 32 ...	531	17
March 32 ...	432	27	March 32 ...	437	7
Total ...	3,025	129	Total ...	2,372	1,070

The above figures show that the largest number of *Diatraea* egg masses collected from both areas was in December, 1931, with 1389 at Swee Lee Estate, and 570 at Bagan Serai. The minimum number collected from both areas was in October with 45 masses at Swee Lee and 42 at Bagan Serai. One egg mass of *Diatraea* was collected at Bagan Serai on the day the collection commenced (October 12th.) but at Swee Lee none was collected until October 17th.

Egg masses of Diatraea at Swee Lee Estate :—During October 45 egg masses of *Diatraea* were collected at Swee Lee, 10 being the maximum in one day. During most of November the numbers remained constant but at the end an increase occurred. The number of egg masses remained high throughout December and commenced to decrease at the beginning of January but there was a large rise in the last week of January. The number of egg masses was low throughout February and this was maintained until about the last week of March, when an increase occurred.

Egg masses of Diatraea at Bagan Serai :—The number of egg masses collected was low throughout October. A marked increase occurred about the third week of November. During December the number fluctuated but decreased considerably towards the end of the month and during January. An increase commenced at the beginning of February, remaining fairly high throughout the month. Towards the end of March the numbers again increased.

There would appear to be evidence to suggest that Diatraea moths are more numerous in some months than in others. From both these areas the largest number of eggs was collected in December. Results in 1930—1931 however, showed that the increase occurred in February.

Schoenobius at Swee Lee :—The egg masses for *Schoenobius* in this area were lower than at Bagan Serai throughout the season. The largest number (71) was collected in December and 10 was the largest number collected on one day (December 13th.). An increase occurred in March.

Schoenobius at Bagan Serai:—The largest number (563) was collected in November. The largest number collected in one day was 61 on December 12th. From this month the collections decreased, only 7 masses were collected in March. In 1930-31 season, most *Schoenobius* egg masses were collected about the end of January and the beginning of February but this season's collections show that at Swee Lee and Bagan Serai, November for the former and December for the latter were the peak months and not January and February. Considerably more work is undoubtedly required to ascertain the causes responsible for seasonal fluctuations.

The natural parasitism of the egg masses collected at Swee Lee Estate and Bagan Serai gave the following result.

1. Diatraea Egg Masses.

Period.	Total No. of masses.	Total No. of masses with *Trichogramma.*	Per cent.	Total No. of masses with 50 per cent. parasitism or over.	Per cent.
October ...	45	Nil	—	Nil	—
November ...	153	3	2.0	3	2.0
December ...	1,389	184	13.2	64	4.6
January ...	901	418	46.4	225	25.0
February ...	105	48	45.7	32	30.5
March ...	432	190	44.0	113	26.2
Total ...	3,025	843		437	
October ...	42	2	4.8	1	2.4
November ...	507	106	20.9	24	2.7
December ...	570	231	40.5	100	17.5
January ...	285	83	29.1	27	9.5
February ...	531	48	9.0	11	2.1
March ...	437	180	41.2	113	25.9
Total ...	2,372	650		276	

At Swee Lee the total number of egg masses collected was 3025 out of which 843 were parasitised by *Trichogramma*, a percentage parasitism of 27.9. Out of the 843 masses, 437 (= 14.4 per cent.) showed 50 per cent. parasitism or over.

At Bagan Serai the total number of *Diatraea* egg masses collected was 2372, of which 650 (= 27.4 per cent.) were parasitised by *Trichogramma*. Out of the 650 masses, 276 (= 11.6 per cent.) showed a 50 per cent. parasitism or over.

The largest number of parasitised egg masses at Swee Lee occurred in January; out of 901 egg masses, 418 were parasitised and 225 of these showed 50 per cent. parasitism or over. The parasitism during January and March remained about 40 per cent. At Bagan Serai the parasitism was lower than at Swee Lee and parasitism only in December and March reached 40 per cent. During March 437 egg masses were collected, 180 contained parasites of which 113 showed a 50 per cent. parasitism or over.

Out of the total number of *Diatraea* egg masses collected at Swee Lee and Bagan Serai only one egg mass collected at Bagan Serai was parasitised by *Phanurus beneficiens*, so that this parasite is not an active enemy of *Diatraea*.

2. Schoenobius Egg Masses.

PERIOD	SWEE LEE ESTATE.						
	Total No. of masses	Total No. of masses with parasites	Total No. of masses with Trichogramma	Total No. of masses with Phanurus	Total No. of masses mixed with Tric. & Phanurus	Total No. of masses with Tetrastichus	Total No. of masses mixed with Tetrastichus & Trichogramma
October ...	3	—	—	—	—	—	—
November ...	12	1	—	1	—	—	—
December ...	71	14	13	1	—	—	—
January	16	8	6	—	2	—	—
February ...	0	—	—	—	—	—	—
March ...	27	18	10	2	1	4	1
	129	41	29	4	3	4	1

PERIOD	BAGAN SERAI.							
	Total No. of masses	Total No. of masses with parasites	Total No. of masses with Trichogramma	Total No. of masses with Phanurus	Total No. of masses mixed with Tric. & Phanurus	Total No. of masses with Tetrastichus	Total No. of masses mixed with Tet. & Tric.	Total No. of masses mixed with Tetra & Phanurus
October ...	103	7	—	7	—	—	—	—
November ...	563	140	38	89	13	—	—	—
December ...	279	185	46	98	41	—	—	—
January ...	101	72	7	44	13	3	3	2
February	17	5	1	2	1	1	—	—
March ...	7	4	1	1	1	1	—	—
	1,070	143	93	241	69	5	3	2

At Swee Lee the total number of *Schoenobius* egg masses collected was 129 out of which 41 were parasitised.

88 not parasitised	...	68.2 per cent.
29 masses by *Trichogramma*	...	22.5 „ „
4 masses by *Phanurus*	...	3.1 „ „
3 masses by *Trichogramma* and *Phanurus*	...	2.3 „ „
4 masses by *Tetrastichus*	...	3.1 „ „
1 masses by *Tetrastichus* and *Trichogramma*	...	1.0 „ „

At Bagan Serai the total number of *Schoenobius* egg masses collected was 1070, out of which 413 were parasitised as follows :—

657 masses unparasitised	...	61.4 per cent.
93 masses by *Trichogramma*	...	8.7 „ „
241 masses by *Phanurus*	...	22.5 „ „
69 masses by *Trichogramma* and *Phanurus*	...	6.4 „ „
5 masses by *Tetrastichus*	...	0.5 „ „
3 masses by *Tetrastichus* and *Trichogramma*	...	0.3 „ „
2 masses by *Tetrastichus* and *Phanurus*	...	0.2 „ „

The majority of the egg masses at Swee Lee were parasitised by *Trichogramma* and the majority at Bagan Serai by *Phanurus*. The highest percentage parasitism occurred both at Swee Lee and Bagan Serai in January, 50 at the former and 71 at the latter area.

Towards the end of February most of the padi plants in both the 1/6 acre at Swee Lee and Bagan Serai were dead and the collection of egg masses was confined to some of the remaining fresh plants and volunteer padi. During March, all the padi plants in the two areas were dead and the collection of egg masses was limited to volunteer padi.

Experiment IV - Light Traps.

Three light traps were set up in the Government Padi Experimental Station at Titi Serong. Ordinary kerosene-burning hurricane lanterns were used as the source of light. The moths were trapped in trays 2 feet square and 3 inches deep, containing water covered with a film of kerosene. Each trap was protected from rain by a roof constructed from nipah leaves.

Two lamps were lit for a part of the night, the third burning all night. The hours during which the lamps were kept alight were as follows :—

No. 1 — 10.00 p.m. to 6 a.m.
No. 2 — 6.30 p.m. to 10 p.m.
No. 3 — 6.30 p.m. to 10 p.m.

The records for this season were taken from June 15th, 1931, to March 31st, 1932. The above arrangement of the light was carried out from June 15th to 31st July, 1931, when only two of the lamps, which were kept alight all night from 6.30 p.m. to 6 a.m., were used.

The results obtained with each of the three species of borer are given separately below ;—

Diatraea auricilia :—From the night of the 15th—16th June to the night of 29th—30th June very few moths were caught. The maximum number of males and females respectively was 4 and 5. During July no moths were obtained. In August, when only two lamps were used a few moths were obtained during the first and second week of the month. Moths were absent again from the night of 13th—14th August till the night of 18th—19th August when a male was caught and another on the night of 22nd—23rd August. During September moths appeared at the end of the first week and were absent again about the end of the month. During October no moths were caught until the third week of the month. In November very few were captured but a slight increase of the females of the species occurred at the end of the month. During December an increase in males and females occurred but the number of males decreased in the latter part of the month. In January *Diatraea* increased, the maximum number of males and females caught in one night was 89 and 102 respectively.

At the beginning of February about the same number of males and females was caught each night, but towards the end of the month a marked increase in the number of females occurred. The largest number of *Diatraea* caught in one night was 571. In March the number of males dropped and of females increased considerably. The maximum number of females caught in one night was 588, the highest number recorded during the season.

The figures below show the catch for each month :—

Period.	Males.	Females.
June 15th to 30th inclusive, 1931 ...	15	16
July ...	Nil	Nil
September ...	31	10
October ...	15	1
November ...	30	36
December ...	239	291
January — 1932 ...	601	632
February ...	629	1,883
March ...	415	3,770

The total number of moths caught from the night of June 15—16th to and including the night of March 30—31st., 1932, was males 1975 and females 6639.

Schoenobius incertellus :—The first considerable increase in the number of moths occurred in December. The total number for the month was 420 males and 105 females. During June, July, August, September, October and November very few moths were captured.

The largest number recorded during the season was 422 males caught in February and 254 females caught in March. The major difference between *Diatraea* and *Schoenobius* at light is that the females of the former and males of the latter predominated.

The total number of moths caught in each month during the season was as follows :—

Schoenobius incertellus.

Period.	Males.	Females.
June 15th to 30th inclusive ...	19	6
July ...	Nil	Nil
August ...	3	15
September ...	50	12
October ...	15	1
November ...	31	9
December ...	420	105
January ...	377	111
February ...	422	124
March ...	31	254

The total number of *Schoenobius* moths caught during the season was 1368 males and 637 females.

Sesamia inferens :—*Sesamia* first appeared in the traps in December, 1931. From December 1931 to March, 1932, the total number caught was 92 males and 4 females.

The table below shows the number caught in each month during the season.

Sesamia inferens.

Period.	Males.	Females.
June 15th to 30th inclusive ...	Nil	Nil
July ...	Nil	Nil
August ...	Nil	Nil
September ...	Nil	Nil
October ...	Nil	Nil
November ...	Nil	Nil
December ...	5	Nil
January ...	5	Nil
February ...	42	1
March ...	40	3

These results differ considerably from those of 1930—31. In the case of *Diatraea* very few were attracted to the light before February, whereas in 1931—32 a marked increase was recorded in December and continued till the termination of this experiment at the end of March. Few *Schoenobius* moths before January 1931 were attracted but this season's result shows a large increase in December. A marked decrease was recorded in March in this season's work, but in 1930—31 the decrease was not recorded till April. It is suggested that these variations may be due to padi being planted earlier in the 1931—32

than in the 1930—31 season but no definite statement can be made at this stage especially since Mr. Pagden is of the opinion that *Diatraea* is to some extent seasonal in the Krian District as evidenced by the usually good crop obtained by early planting even when the area is adjacent to one planted later and subsequently subject to heavy attack.

SUMMARY

Experiment I.
Stem Counts.

About the same number of tillers was attacked in the Colonised and Uncolonised areas but the stems in the Uncolonised area contained more larvae and pupae than in the Colonised area.

Trichogramma cannot be stated to have prevented the boring of stems.

Experiment II.
1. Natural and Induced Parasitism.
Diatraea.

In the plots receiving parasites, no increase of parasitism after the liberation of parasites was recorded, but in the Uncolonised plots an increase of about 7 per cent. in natural parasitism occurred.

Schoenobius.

In the Colonised plots the percentage parasitism increased by 29 per cent.

In the Uncolonised area, natural parasitism increased by 12 per cent., indicating a possible increase due to *Trichogramma* of 17 per cent: such a deduction, however, is not supported by the result obtained in the *Diatraea* collection.

Chilo.

Trichogramma is not an active parasite on the eggs of this moth. This parasite only emerged from one egg mass out of 68 collected.

2. Stem Counts.

A larger percentage of stems was bored in the Colonised than in the Uncolonised areas.

3. Harvesting.

A larger yield was obtained from the Uncolonised than from the Colonised areas.

Experiment III - Seasonal Occurrence of Borers.

1. Diatraea.

Swee Lee — Diatraea increased at the end of November and continued during December. An increase was also recorded in March.

Bagan Serai — Diatraea increased towards the end of November, decreased considerably towards the end of December and increased again in February.

The increase during 1930—1931 padi season occurred in February.

Diatraea is more numerous in certain months and there would appear grounds for supposing that it may be seasonal as this result indicates that more eggs masses were collected at Bagan Serai about a month earlier than at Swee Lee.

2. Schoenobius.

Schoenobius was more numerous at Bagan Serai than at Swee Lee and would appear to be more prevalent at Bagan Serai a month earlier than at Swee Lee.

3. Trichogramma.

Trichogramma from the *Diatraea* egg masses was obtained in October at Bagan Serai and in November at Swee Lee and from *Schoenobius* in November at Bagan Serai and December at Swee Lee.

Experiment IV - Light Traps.

Moths were attracted to light traps a month earlier than in 1930—31.

It is impossible to say whether these moths are seasonal but increases seem to occur as the supply of food material increases.

Discussion.

The 1931—1932 experiments have revealed that the study of these borers is attended with endless difficulties and that considerably more work will be required before efficient measures for their control can be recommended. The results of the investigations made during the past two years indicate that Trichogramma cannot be considered as an effective parasite in the control of padi stem borers even when liberated in large numbers. The liberations made during the 1930—31 padi season, recorded in *Malayan Agricultural Journal*, March 1932, showed a marked increase in parasitised ova but in the case cited the total rate of liberation was 1,300,000 parasites per acre, parasites being liberated daily from the beginning of the padi season until ripening of the grain,

an impossible procedure where large areas may have to be colonised. Furthermore, it should be noted that only *Diatraea* was attacked to any extent, *Schoenobius* being nearly immune owing to the hairy covering of the egg-masses.

In the experiments recorded above an attempt was made to put the liberation of parasites on a more economic basis by liberating in smaller numbers for a short period at the first sign of an increase in borer activity, but even here, although 200,000 parasites per acre were used, the results demonstrate that in these numbers the parasite is ineffective.

THE VEGETATION OF THE RICE LANDS IN NORTH KEDAH.

BY

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In the present paper an account is given of the vegetation, from an agricultural standpoint, in the large areas of North Kedah which have been cultivated with rice for many years. The soil of these lands has in course of time become consolidated and edaphic and other factors are fairly stable, whereas, in the more recently cleared areas, such as those that were under swamp jungle, the fields are, as a rule, soft and boggy and contain a high percentage of vegetable débris, with the result that, as cultivation proceeds, their soils and plant populations are subject to fairly rapid changes.

Description of Rice Lands.

The rice areas are situated on a large alluvial plain which follows the west coast of the State and extends from Gunong Jerai (Kedah Peak) in the south to the Perlis State boundary near Kodiang in the north. The plain has a total length of about 44 miles and a breadth of from 8 to 14 miles. The soil is usually several feet deep and consists mainly of stiff clay, but somewhat lighter clays occur in certain places.

The greater portion of the land is free of virgin or secondary jungle, but along the coast quite extensive belts of swamp jungle remain which are slowly being cleared and brought under cultivation. These areas, which generally possess good rice soil, are known as 'hutan gelam' on account of the preponderance in them of the cajuput oil tree (*Melaleuca leucodendron,* Linn.). There are, also, a few fairly large uncultivatable swamps in inland places with little or no tree growth.

Throughout the plain there are numerous large and small controlled drainage canals by means of which water from small streams and rainfall is conserved and utilized on the fields and which also serve to carry off any excess of water after, and during, periods of heavy rainfall.

The waters of the two large rivers, namely, the Muda river to the south-east, and the Kedah river in the north, are not brought to the lands; there is, therefore, no large system of perennial irrigation with the result that during periods of drought, crops, the indigenous vegetation and live-stock, may suffer considerably.

Rainfall and Climate.

In Alor Star, which town is situated in the centre of the area, the average monthly rainfall, in inches, of the past ten years, 1923—32, was as under :—

January	1.86 inches	July	5.27 inches
February	1.77 „	August	9.85 „
March	5.39 „	September	11.42 „
April	8.13 „	October	12.85 „
May	10.24 „	November	7.50 „
June	8.82 „	December	6.03 „

The average annual rainfall is heavy, being 89.13 inches. The wettest months are May, August, September and October, but the incidence of the rainfall varies from season to season, so that June, November, or December, may be very wet months in particular years. In most years there is a fine, dry period, with strong north-west winds, extending from the middle or end of December to March. In March, the weather is usually showery, whilst that of April is much wetter.

Methods of Cultivating Rice Fields.

There are two methods of preparing the land for planting, namely, by ploughing, raking and rolling it, or by simply cutting down the vegetation, which had developed since the last harvest, to the surface of the soil and placing it in heaps to decay. Both systems have for their object the destruction, as far as possible, of the plant growth which has developed during the previous 4 or 5 months, and also to provide suitable conditions for planting. All operations are carried out when the fields are flooded, but not deeply. Of the two methods employed the first is more efficient in destroying grasses, sedges, and other plants, but neither effects their complete eradication.

Cultivation is usually commenced in May, if sufficient rain has fallen by that time, and is continued until planting has been completed in July, August or early September. Harvesting takes place from the end of December to about the end of February, and after harvest, the straw and a good deal of the stubble are burnt on the land. The fields at this time are, therefore, practically devoid of green vegetation, except along bunds and drains, in water-holes and low-lying places.

Following harvest the soil becomes very dry, hard and cracked and remains so until showers fall in March. Under normal circumstances therefore, there is only a period of about 4 to 5 months in which fortuitous vegetation can develop in the arable areas, and this is frequently grazed over by buffaloes and cattle with which animals the State is well stocked.

The Plant Population of the Fields Before Cultivation.

During the period which elapses from harvest to the commencement of cultivation the fields become covered with a growth of grasses, sedges, rushes and other plants, which growth varies considerably with the fertility of the soil, the level of the land and the amount of rainfall received.

The small bunds that divide up the fields into small divisions and serve to retain water on the land usually support quite a number of species. Among the grasses may be mentioned Bermuda grass (*Cynodon dactylon,* Pers), 'halia' (*Panicum repens* Linn); love-grass (*Chrysopogon aciculatus,* Trin); 'kusa-kusa' (*Echinochloa colona,* Link); 'sayap gagak' (*Paspalum Commersonii,* Lam); 'gerek telinga' (*Ischaemum aristatum* Linn); pasture grass (*Oxonopus compressus,* Beauv) and in certain places, *Apocopsis siamensis,* Camms. On broader bund, roadsides and banks, these plants together with 'lalang' (*Imperata arundinacea,* Cyr) and a useful grass with which it is commonly associated, namely, *Amphilophis glaba,* Staph, thrive well.

Other common bund plants are 'bujang semalam' (*Jussiaea suffruticosa,* Linn); 'rumput aur' (*Commelina nudiflora,* Linn) and *C. salicitolia,* Roxb; 'biu' (*Eclipta alba,* Hassk); 'gelumak susu' (*Sphaeranthus africanus,* Linn) and 'lemak ketam' (*Melochia corchorifolia,* Linn). To the above list could be added several species of sedges and other plants, but the grasses only are of agricultural interest as they provide quite considerable quantities of food for live-stock during several months of the year.

In water-holes, drains and swampy places strong growing grasses and sedges form the greater part of the plant population. Here are found 'kumpai' (*Hymenachne Myuros,* Beauv), 'salit' (*Leersia hexandra,* Sw); 'padi yang' (*Oryza fatua var longearistata*); 'halia' (*Panicum repens,* Linn); *Charmaeraphis squarrosa,* Merr and several other water-loving grasses and sedges. The dominant species found almost everywhere in these places is the robust sedge, 'menderong' (*Scirpus grossus* L). In open water and drains there occur 'rumput ayer' (*Monochoria vaginalis* Presl); 'kangkong' (*Ipomoea reptans,* Forsk) also the water-lily (*Nymphaea stellata,* Willd) and other floating plants such as *Jussiaea repens* Linn; *Neptunia oleracea,* Low; *Limnanthemum indicum,* Thw; 'kambiang' (*Pistia stratiodes* Linn) and the water-hyacinth (*Eichornea crassipes,* Solms). With the exception of the grasses which provide a certain amount of forage, the other plants are not of much value. On the other hand, these water-holes and swampy places do form centres from which troublesome weeds and pests may spread to growing crops.

The vegetation of the areas above described is of minor importance compared with that of the cultivated fields. It has been mentioned that after the rice-crop has been harvested in the dry season, the straw and most of the stubble are burnt, and the land left almost bare. A few shoots may develop from the stubble that remains, but these are short-lived. As soon as rain falls, however, the padi which had been scattered over the ground during harvesting operations—and this is always quite considerable in amount—quickly germinates, as does the seed of other plants, such as grasses, sedges and rushes, but more particularly that of the grass 'sayap gagak' (*Paspalum Commersonii*). The rhizomes of certain grasses and sedges which have survived weeding and burning operations also start new growth. The grasses namely, 'sabut'

(*Charmaeraphis squarrosa*), 'padi yang' (*Oryza fatua var longe-aristata*); *Echinicholœ Crus-galli* and 'halia' (*Panicum repens*), together with the sedge 'menderong' (*Scirpus grossus*) may be specially named.

The more important plants are volunteer rice and the 'sayap gagak' grass. These grow very rapidly and provide, when young, good grazing for working animals especially buffaloes. 'Sayap gagak' occurs in abundance. It is an annual grass with numerous short, thick stems that lie close to the ground and which often completely cover the soil. The ripe seed of the plant can remain in a dormant condition when submerged in mud and water for 7 months or more; it then germinates freely after the first showers following dry weather, and usually completes its growth before the fields are deeply flooded. The plant is readily destroyed by ploughing and flooding, and although it is not a hydrophyte, it is one of the most useful grasses which grow in the fields after harvest. 'Sabut' (*Charmaeraphis squarrosa*) is a perennial creeping Siamese grass which, until these investigations were started, had not been recorded from any part of Malaya. It has probably been in the State for several years as it is fairly widely distributed. In dry weather its stems and leaves closely resemble Bermuda grass (*Cynodon dactylon*) and may be easily mistaken for that species. It has long, thin, wiry rhizomes which root freely and send up shoots from all nodes. After the fields are flooded it produces floating stems and rather broader leaves. Owing to the plant being a hydrophyte, and also because it can survive periods of drought, it is a most difficult grass to control in the fields. 'Padi yang' (*Oryza fatua var longe-aristata*), is a wild rice which produces long floating stems and ears of long-awned padi. It is a fairly common plant in some areas and has most likely been introduced from Siam for growth in deep-water situations in order to provide forage for live-stock. It is, however, a very troublesome weed in cultivation. *Echinochloœ Crus-galli* is a rice-like annual plant which nearly always occurs sporadically, but is not difficult to deal with. 'Halia' (*Panicum repens*) like *Charmaeraphis,* always gives much trouble in weeding. It produces long deep-rooting rhizomes and narrow glaucous leaves. It can withstand dry conditions and thrive in water. Another weed-pest in lands cultivated by means of implements is the large sedge, 'menderong' (*Scirpus grossus*). This robust species produces numerous subterranean rhizomes which penetrate so deeply into the soil that they cannot be uprooted by the light native plough. It has, therefore, to be dealt with by hand. In the rice fields of the Krian district of Perak, this sedge is the chief source of supply of organic matter, but as no ploughing is done there, it is not considered to be a troublesome plant. In North Kedah, however, every effort is made to keep it under control. It has no feeding value for animals.

It will be seen, therefore, that apart from volunteer rice and 'sayap gagak', relatively few useful and harmless plants develop in the fields from harvest to planting, but these are of considerable value as green manure and for supplying food for working animals. Along drains and bunds, more species, chiefly dry land ones, occur, and these also provide limited amounts of forage.

The Weeds of the Flooded Fields.

The chief plants of the flooded fields are those mentioned above together with small sedges and rushes. In most seasons, however, the submerged species, 'lumut rumput' (*Blyxa Malayana,* Ridl) and the 'bladder-wort' (*Utricularia flexuosa,* Vahl) are present, whilst in particular years when the rainfall is heavy and fairly continuous over a period of two months or more, two other plants develop in the water to such an extent that the growth of the young rice plants is impeded; these are *Enhydrias angustifolia,* Ridl and *Chara gymnopitys,* Brann. With Utricalaria they are collectively termed 'lumut' or moss. As these submerged hydrophytes have formed the subject of a recent article by Sands (N.H.) in *Malayan Agricultural Journal,* Vol. XXI, No. 4, they need not be referred to at length here.

The Plants of Drained Rice Lands.

If land which has been cultivated with rice for many years is levelled and drained, indigenous plants, chiefly grasses and sedges, establish themselves to form rough pastures unless they are regularly mown or grazed over. Owing to the clay soil, combined with alternate periods of dry and wet conditions, the permanent pastures which are eventually formed are generally poor in useful species. It is very difficult to prevent water-logging of the surface soil of these level areas in months of heavy and frequent monsoon rainfall, except by the adoption of rather costly and elaborate systems of drainage.

Observations were made in two large areas near to Alor Star which had been reclaimed from rice and allowed to revert to pasture, these were :—

(*a*) The Golf and Race Course Reserve,
and (*b*) The Alor Star Aerodrome.

(a) The Golf and Race Course Reserve.

This is an enclosed area of old rice land some 95 acres in extent, which was taken over, levelled and drained sixteen years ago. Certain portions such as the race course, fairways and the greens are regularly scythed or mown. Others, chiefly under 'lalang' (*Imperata arundinacea*) are burnt annually. Besides these areas there are others which are low-lying and which are rarely interfered with in any way.

The whole reserve is surrounded and crossed by large open drains and there are, besides, numerous rubble sub-soil ones. Notwithstanding this drainage, a large proportion of the area becomes water-logged on the surface, often for many consecutive days, in the wet months of the year. In the dry season the soil becomes very dry and its surface cracked.

In the areas which are regularly mown the dominant species is the love-grass (*Chrysopogon aciculatus,* Trin.) There are also small scattered patches of the wiry, tufted grasses *Dimeria ornithopoda* Trin, 'kutu kerbau' (*Eragrostis elongata* Jacq and 'tulang belalang' (*Eragrostis tenella* R and S.). The pasture-grass (*Axonopus compressus* Beauv); the creeping 'gerek telinga' (*Ischaemum aristatum,* Linn); 'halia' (*Panicum repens,* Linn); *Paspalum longifolium* Roxb; *Apocopsis siamensis,* Comm. and young shoots of 'lalang' (*Imperata arundinacea,* Cyr) also occur. Among these grasses are small tufted sedges. The love-grass is by far the most useful pasture grass here, as it covers the ground well and withstands adverse soil conditions. Alone it provides rather poor feeding, but when associated with 'gerek telinga' and the newly discovered grass, *Apocopsis siamensis,* Camms, quite good pasturage is formed. The *Apocopsis* is rather like 'gerek telinga'; it has the same creeping habit, but narrower leaves. This Siamese grass, like *Charmaeraphis squarrosa,* had not been previously recorded in Malaya, still it is quite common in the neighbourhood of Alor Star and thrives well under local conditions.

In uncut fairly well-drained places 'lalang' (*Imperata arundinacea*), although burnt periodically, forms dense masses of growth to the exclusion of other species, still in patches where the growth of it is thin, 'gerek telinga', 'halia' and *Paspalum longifolium,* Roxb, are able to develop. These grasses together with young 'lalang' are regularly cut for fodder in dry weather. In the low-lying places which are not well drained, such as those previously described, and rarely touched, there is a large number of sedges with patches of 'halia', 'gerek telinga', *Dimeria ornithopoda, Sacciolepis turgida* Ridl, love-grass and a few other plants. The grasses occur mostly in tufts so that the soil is not closely covered by vegetation as in the better-drained areas due, of course, to the rather prolonged flooding which is periodically experienced.

(b) The Alor Star Aerodrome.

This area is situated about 7 miles north-east of Alor Star. About 2 years ago approximately 200 acres of rice-land was acquired for use as an aerodrome. The land was levelled and drained. The drainage consisted of a large open ditch surrounding the area into which were led numerous subsoil drains. The surface soil was rather lighter than that of the Golf and Race Course reserve. No special planting of grass was undertaken so that the vegetation which is now found on the site has been established by natural means. The chief problem which has confronted the aerodrome authorities has been the quick disposal of the water which accumulated on the surface of the soil to a depth of 2 to 4 inches after heavy rain. This water-logging also impeded the growth of pasture grasses. The vegetation is cut over at regular intervals.

Unlike the older established golf course area, 'lalang' and love-grass are not present to any extent, but the wiry tufted grasses, 'kutu kerbau' (*Eragrostis elongata*), 'tulang belalang' (*E. tenella*) and *Dimeria ornithopoda* are common. These with *Paspalum longifolium*, 'halia' (*Panicum repens*) and 'gerek telinga' (*Ischaemum aristatum*) are the chief grasses, but as expected, under the conditions described, small sedges abound.

From a pasturage point of view the most useful grass is 'gerek telinga' (*Ischaemum aristatum*) as it covers the soil well where it grows, and is much liked by grazing animals. Leguminous plants are comparatively rare; however, the hardy little 'omba omba' (*Desmodium heterophyllum* D.C.) and a rather woody straggling species *Geissasapis cristata* W. and A. which resembles a Desmodium, are present.

The adverse effects of dry and wet conditions, but more particularly the latter, on the character of the plant population of the permanent pastures is clearly seen here as elsewhere.

General Remarks Concerning Pastures.

The amelioration of the local soil conditions by effective drainage in order to obtain better pasturage is difficult to accomplish even in unbunded areas, still, studies and trials should be made, of selected indigenous grasses that are known to thrive under local conditions. Some of these grasses have already been mentioned. It is possible, also, that certain exotic grasses, such as carpet grass (*Axonopus compressus* var.) and Australian blue couch (*Digitaria didactyla*) might prove of value, nevertheless, unless an introduced species can compete successfully with local grasses when associated with them, it is not likely to prove of permanent value. That this is possible is shown by the natural spread of the useful Siamese grass, *Apocopsis siamensis*. On the other hand, care must be exercised that plants which may become troublesome weeds are not introduced and allowed to escape, such as has apparently been the case with the grass *Charmaeraphis squarrosa* and the wild-rice, *Oryza fatua var longe-aristata*, of the rice fields.

Further, it remains to be demonstrated whether it will be sound agricultural practice to allow undrained portions of rice-land with opens bunds to remain temporarily uncultivated for one or two seasons in order that indigenous plants may develop on them for the purpose of improving the physical and chemical properties of the soil and to provide grazing for live-stock.

Acknowledgment.

The writer is much indebted to the Assistant Principal Agricultural Officer (H.H. Tunku Yacob) for his valuable assistance in the investigations and also

he desires to acknowledge the most useful help rendered by the Director of the Botanic Gardens, Singapore (Mr. R. E. Holttum) in the identification of several of the grasses. He also appreciates the loan of herbarium specimens by the Botanical Division of the Department of Agriculture, S.S. and F.M.S., for identification purposes.

Summary.

(*a*) An account is given of the rice lands in North Kedah together with a description of the soil, climatic conditions and methods of cultivation.

(*b*) The indigenous plants of the fields in different situations are described.

(*c*) The chief weeds of the cultivated areas are named and their characteristics discussed.

(*d*) A description is given of the plant associations of two large areas of pasture land which had been reclaimed from rice for 16 years and 2 years respectively.

(*e*) The possibility of improving local pastures by the selection of useful indigenous species and the introduction of exotic ones is referred to.

Miscellaneous Article.

CONDITIONS ON SMALL RUBBER HOLDINGS IN MALAYA.

2nd Quarter 1933.

Prepared by the Economics Branch of the Department of Agriculture, S.S. and F.M.S. in collaboration with the Field Branch of the Department of Agriculture.

Rainfall.

In April, the rainfall approximated to normal throughout the Peninsula being somewhat heavier in the inland regions than on the East Coast. In May, rainfall decreased after the middle of the month in most areas north of Krian: from there southwards however, the precipitation was heavy throughout the month being somewhat above normal in some districts. Rainfall approximated to normal in Malacca, Singapore and East Pahang..

As usual June was a fairly dry month throughout the country, Malacca being the only place where the rainfall showed any appreciable increase over the average figure for this month.

Prices.

Table I, included in this article, shows the range of prices among local dealers for small-holders' rubber over numerous centres throughout the country where various factors, such as transport and competition, necessarily affect the prices paid to the producer. The table includes the average monthly Singapore prices for standard sheet and the prices quoted at the end of the month by the large dealers for small-holders' rubber, for the purpose of comparison. All quotations are given in Straits dollars and cents for the price per picul (133⅓ lbs.).

The following table shows the trend of average prices per picul ruling in Singapore for Kampong rubber during the first six months of 1933.

	Average price for Smoked Sheet $	Average price for Unsmoked Sheet $	Average price for Scrap $
January ...	8/-	7/-	3/20
February ...	7/50	6/70	2/40
March ...	7/60	6/80	2/50
April ...	7/80	6/80	2/70
May ...	11/80	11/-	5/-
June ...	13/50	12/25	5/-

Table I.

Rubber Prices [in Straits dollars per picul (133⅓ lbs.)]

2nd Quarter 1933.

	Singapore standard sheet Average	Singapore for small holder's rubber at end of month	Penang for small holder's rubber	Perak	Selangor	Negri Sembilan	Pahang	Malacca	Province Wellesley	Kedah	Johore
					APRIL						
Smoked sheet.	9.22	7.80	—	6.30-9.50	6.80-9.50	7-9.30	6.60-9.30	6-9.20	6-9.35	6.50-11.40	5.50-9.50
Unsmoked sheet.		6.80	6.20-8.60	4.50-8	5.50-8.10	5-8.30	5.50-8.40	5.50-8	6-8.50	5.50-8.50	4-9
Scrap		2.70	2-3.30	1-3.50	1.50-3.50	1-3	1.50-3.30	1.50-3.50	2-3.50	2.20-3.50	1.30-4
					MAY						
Smoked sheet	11.10	11.80	—	8-12	9-13	10-12	9-11.60	8-12	8.50-12.25	10-11.60	7.85-11.60
Unsmoked sheet		11	8.60-10.70	6.50-10.80	8-11.50	6-11	8-10.20	6.50-11	7-11.25	8.25-10.60	6.85-11
Scrap		5	4-5.10	1.50-4.50	1.80-5	2-4.50	2-4.50	2-4	2-5.50	2.90-4.40	2-5.50
					JUNE						
Smoked sheet.	14.99	13.50	—	8-14.50	9.75-15.25	7-15	10-15.50	13-14.50	11-13.60	11-14.70	10.30-15
Unsmoked sheet.		12.25	11.20-14	5.80-13.50	9.50-13.50	8-12.60	8-14	11-13.50	9.10-14	8.70-12.50	7-13.50
Scrap		5	4.70-6.60	1-6	2-6	2-5	2-6.50	2.50-6	3.30-6	3.10-6	2-5.50

Table II

Estimated Acreage of Tappable Rubber which was out of Tapping on Holdings of less than 100 Acres, during June, 1933.

PERAK				SELANGOR				NEGRI SEMBILAN				PAHANG			
District	Total Tappable area	Total area untapped	Percentage	District	Total Tappable area	Total area untapped	Percentage	District	Total Tappable area	Total area untapped	Percentage	District	Total Tappable area	Total area untapped	Percentage
Batang Padang	37,288	4,475	12	Klang	18,879	4,530	24	Seremban	19,241	5,772	30	Raub	7,361	442	6
Kinta	34,180	1,367	4	Kuala Langat	29,263	2,634	9	Tampin	17,947	1,615	9	Kuala Lipis	15,951	4,307	27
Kuala Kangsar	43,485	2,174	5	Ulu Langat	38,867	3,887	10	Kuala Pilah	17,470	3,494	20	Bentong	13,600	2,992	22
Upper Perak	13,774	3,306	24	Ulu Selangor	30,632	3,676	12	Jelebu	6,270	439	7	Other Districts	31,223	5,620	18
Larut & Selama	51,407	10,281	20	Kuala Lumpur	21,174	3,682†	12†	Port Dickson	10,653	2,130	20				
Krian	9,751	585	6	Kuala Selangor	9,379										
Lower Perak	47,937	2,397*	5*												
	237,822	24,585	10		148,194	18,409	12		71,581	13,450	19		68,135	13,361	20

MALACCA				PENANG & P. WELLESLEY				SINGAPORE			
District	Total Tappable area	Total area untapped	Percentage	District	Total Tappable area	Total area untapped	Percentage	District	Total Tappable area	Total ar a untapped	Percentage
Central	17,687	5,837	33	North	3,241	421	13	Singapore	12,781	5,751	45
Alor Gajah	31,387	8,474	27	Central	7,067	424	6				
Jasin	24,97	1,748	7	South	8,149	244	3				
				Dindings	7,279	2,620	36				
				Penang	11,114	2,223	20				
	74,045	16,059	22		36,850	5,932	16		12,781	5,751	45

The percentage of areas out of tapping in March, 1933, was as follows :—Perak 25, Selangor 20, the Negri Sembilan 30, Pahang 39, Malacca 37, Penang and Province Wellesley 40, Singapore 62.

* Estimated from same percentage as shown in Kuala Kangsar District.

† Estimated from mean percentage for remainder of State.

Figures of total tappable area differ from those shewn in the report for the preceding quarter in that a total of 17,911 acres, being the area planted in 1927, has now been included.

Tapping.

Reports throughout the country indicate that there has been a considerable increase in the areas tapped among small holdings consequent on the rise in price of rubber during the quarter. In Penang and Province Wellesley it is said that somewhat severe tapping systems are in vogue among small-holders while reports from the Negri Sembilan state that newly opened tapping cuts have been observed in a few cases at a height of 6 feet.

Owing to the increased number of holdings in tapping in Singapore, the shortage of labour consequent on repatriation of a large number of Chinese coolies in the past is now being felt. In Kedah, it is anticipated, if further holdings are brought into tapping, there will be a scarcity of labour available for padi cultivation.

The bagi-dua system of tapping is increasing in popularity during the padi planting season.

Areas out of Tapping on Small Holdings.

The method of estimating the area untapped among small holdings by means of counting the number of such holdings along the sides of main roads was again employed at the end of this quarter.

Table II shows the result of this computation as applied to the known area of tappable rubber, 1927 planting and earlier.

It will be seen that the recent rise in price of the commodity has had a very definite effect on the areas tapped throughout the Straits Settlements and the Federated Malay States; the decrease in the untapped areas recorded are as follows:

The total area of tappable rubber on estates of less than 100 acres which was untapped in the Federated Malay States in June 1933 is estimated on the foregoing system as amounting to approximately 56,355 acres, as compared with 133,000 acres in March of this year or a decrease of 76,645 acres.

The total area untapped in the Straits Settlements in June is estimated to be 27,742 acres as compared with 49,000 in March 1933, or a decrease of 21,258 acres.

Diseases.

Mouldy Rot.—The rainfall in April and May was the cause of a general recrudescence of mouldy rot in most infected areas with the exception of Selangor and Perak North, where, in spite of wet weather, increase in the incidence of this disease was very slight. The dry weather in June effected, to a great extent, the normal natural control.

Oidium Heveae.—This disease is reported to have been prevalent in both the Negri Sembilan and in parts of North Johore; no noticeable damage caused by Oidium has, however, been observed.

Pink Disease.—Cases of Pink disease have been observed in the mukims of Sungei Jambu and Ijoh in Kuala Selangor and in the small areas of the Segamat district of Johore. Satisfactory measures for its treatment have been carried out.

Root Disease.—The only report which has been received in this connection is one from the Selama District of Perak where, it is stated, increased attention is being paid to control measures on small-holdings.

Grades of Rubber Made.

Figures of the percentages of the various grades of rubber produced, where these have been recorded, are as follows :—

Perak : Larut and Matang :—(figures from 12 dealers) smoked sheet 15, unsmoked sheet 60, scrap 14, lump 11.
Selama :—smoked sheet 80, unsmoked sheet 16, lump and scrap 4.
Kuala Kangsar :—(6 dealers) smoked sheet 35; unsmoked sheet 36, scrap 29.

Selangor : Ulu Selangor District only :—smoked sheet 89, unsmoked nil, scrap and lump 11.

Negri Sembilan : Rembau, Kuala Pilah and Jelebu :—(7 dealers) smoked sheet 12, unsmoked 66, scrap 22.

Malacca : all Districts (32 dealers) : smoked sheet 20, unsmoked sheet 63, scrap 17.

Slab is still produced in moderate quantities in the Krian, Larut and Matang district of Perak; its production elsewhere is insignificant.

Prices obtained for this grade of rubber in the Krian district ranged from $2 to $3.50 per picul, and in Larut and Selama from $3.50 to $5.50 per picul throughout the period under review.

Tendency to Abandon Rubber Cultivation for Alternatives.

With the exception of Malacca and Negri Sembilan, where further small areas of rubber have been cut down to make way for the planting of food crops, this practice, generally, appears to have entirely ceased.

General.

The improvement in the rubber market has caused a corresponding renewal of interest in the cultivation of the crop, with the effect that in parts of Perak, Pahang and Johore the clearing of undergrowth has been carried out on a number of small holdings.

A report from Johore also states that many holdings have been newly brought into tapping. In the Batang Padang district of Perak an area of 140 acres of young rubber has been newly opened during the quarter.

The estimated production of rubber by estates of less than 100 acres in area for the first six months of 1933, is shewn in Table III.

Table III.

Estimated Production of Rubber by Estates of less than 100 acres in area during the period January to June, 1933.

1933.	F.M.S.	S.S.	U.M.S.	Total Malaya.
January ...	8,180	2,199	5,727	16,106
February ...	6,232	1,592	4,979	12,813
March ...	7,441	1,948	5,447	14,836
April ...	7,271	1,749	5,876	14,896
May ...	9,331	2,245	6,825	18,401
June ...	10,192	2,536	6,274	19,002

Abstract.

INDUSTRIAL USES OF RUBBER LATEX.*

It is well known that although travellers of the 16th century recorded the fact that South American natives produced various rubber or rubbered articles with the aid of latex, rubber manufacture in civilized countries was originally based on the use of dry rubber.

The alternative method of handling rubber for manufacturing purposes at that time was by forming a solution in a suitable solvent such as turpentine and to use this for water proofing and similar purposes.

It is easy to appreciate therefore, that the advantages of latex as a form of rubber for manufacturing purposes must frequently have been entertained by rubber manufacturers. Thomas Hancock himself in 1824 tried rubber latex for converting cheap fibrous material into an artificial leather; and he filed a patent for the process. It is of importance to note that this process actually preceded an alternative one patented by him in 1825 with the same aim, but using rubber solution. Unfortunately this latex process, together with other latex processess of Hancock for the impregnation and coating of ropes and cordage patented in 1825, and for proofing with latex patented in 1830, experienced an effective check through the inability to obtain substantial supplies of rubber latex.

Thomas Hancock was convinced of the practicabilities of latex transport, but was unfortunate in two respects. The small quanities of latex which he secured for his small-scale experiments appear to have been wrongly described to him as Hevea latex. Consequently when he appointed an Agent in Tampico to export Hevea latex in bulk, the deliveries of the much less stable Hevea latex arrived repeatedly in a coagulated condition and necessitated abandonment of his latex processes. Also only at the time of the writing of his memoirs many years later was he in a position to record the fact that ammonia had been found to be an effective preservative for latex, this discovery having been made about 1853.

The number of patents for latex processes must now reach several thousands. Somewhat surprisingly the reduction in the price of raw rubber of recent years has not been altogether favourable to the adoption of latex processes. A reason for this is that the small premium on the price of latex rubber for special handling and additional transport charges becomes a much greater percentage of the cost of raw rubber when the latter is near 2d. a lb. than when it is 2s. per lb.

On the other hand however, the reduction in the cost of raw rubber has increased the advantages of latex for purposes which cannot well be served by ordinary rubber and where latex has to compete primarily with non-rubber materials.

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* Abstracted from the Journal of the Society of Chemical Industry, Vol. 52, No. 19, May 12th, 1933.

Technical Advantages.

The main advantages of latex are as follows :—

1. The rubber is available in a fluid condition without the cost and ill-effects of mastication. The latex is easily used for purposes such as spreading or soaking; further it can be compounded without the need for heavy machinery involved in ordinary rubber manufacture.
2. Latex contains a much higher proportion of rubber than rubber solutions of equivalent viscosity. The proportion of volatile medium to be removed is therefore considerably less.
3. Not only is the cost of the rubber solvent eliminated, but the fire risk and health hazards of the common solvents are obviated.
4. Latex by induced coagulation readily yields solid rubber (admittedly wet) when required, whereas solutions normally have to be evaporated more or less completely. Articles can therefore be removed at an early stage from formers, moulds, etc., permitting the rapid return of these to the cycle of operations.
5. On account of the avoidance of the development of heat which arises in the milling of raw rubber, it is possible to use freely, the most powerful accelerations of vulcanization in latex-compounding without fear of trouble from scorching or premature vulcanization. The low temperature of eventual vulcanization permits the use of bright organic pigments which would be discoloured in ordinary heat vulcanization.
6. The latex rubber products normally contain a full proportion of the natural anti-oxidant constituents of the latex and so *ceteris paribus* show better ageing qualities in addition to the greater mechanical strength arising from the unworked condition of the rubber.

Features of latex constituting possible disadvantages are :—

1. The need of a small proportion of some form of preservative or stabilizing agent, e.g. 0.5% of ammonia or 1% of potassium hydroxide.
2. The need for removal of water at some stage of manufacture.
3. The lower stability relative to rubber solutions, for example for storage. On the other hand the lower stability is a distinct advantage for some operations.
4. The incorporation of reinforcing agents, the full effect of the latter is at present more difficult than with dry rubber.

Methods of Use.

The methods by which latex may be used in manufacture fall generally within the following group of processes : spreading, soaking, spraying, dipping, electrophoresis, gelling, frothing, flocculation, crumbing and moulding. These terms are used in a wide sense, for example, spreading and dipping cover also such uses as the application of latex either as an adhesive for assembling in boot and shoe manufacture or as a bonding agent for abrasive and other materials.

Dipping Process. The principle of this process can be applied in a variety of ways. A plain dipping process can be used for the production of such articles as sacs for fountain pens and other purposes, tobacco pouches, rubber shoes, teats, surgeons' gloves etc. The dipping process can be used with ordinary latex (which customarily will have been compounded), but in order to reduce the number of immersions to build up an article of the necessary stoutness of wall, latex of increased viscosity and also increased concentration is to be preferred. Vulcanization can be effected during the drying or subsequenlty.

Filtration has been commercially applied in United States of America as a method for the production of motor tubes by immersing a perforated mandrel coated with superposed layers of fabric and cohesive wet powder such as clay in compounded latex; the serum passes through to the interior of the mandrel which is under reduced pressure, and a compact coating of wet compounded rubber gradually forms on the outer surface.

Spreading, which may be considered as a special case of a dipping process is to-day applied in many different ways, and in some directions on a very large scale for manufacturing purposes. Large quantities of latex variously compounded are used as or in adhesive or stiffening material in the manufacture of ordinary shoes (in preparing constructional parts and in marking cutting blocks), the consumption in this direction in 1930 being equivalent to 8,000,000 lb. of rubber. Large quantities are also used for the sealing of millions of cans. The seam in the side of the can and between the side and the base being filled with a core of rubber composition which is applied in the form of a latex paste. Latex is also used on a large scale for proofing textiles of all kinds, *e.g.* for rain coats and for producing spread rubber sheet.

Horse hair or similar fibre for upholstery is treated in its final expanded condition with compounded latex so that after drying and vulcanization, the relative position of the individual strands is fixed giving increased resilience and permanence of shape. A mixture with gelatin or with gelatin and glycerol has been applied to reduce the permeability and consequent leakage of gas bags for air ships and of inner tubes for motor tyres.

One of the early suggestions in the latex "renaissance" was that of F. Kaye in 1920 for its use as a sizing material in paper manufacture. Although this suggestion has not been adopted as widely as seemed likely at first, it contained the germ of the idea for the use of latex in bonding fibrous materials generally. To-day, latex is used largely as a binding agent *e.g.* for bonding abrasives, and to convert leather dust or disintegrated fibre into artificial leather, to consolidate crumbed rubber waste into various products and, mixed with emulsified wax, to proof cork lids and cardboard containers. Large-scale experiments are in progress in different parts of the world on its application as a binding material with or without cement for road construction and surfacing.

In this direction a mixture of stabilized latex with cement and with or without other fillers (including emulsified bitumens) is of especial promise. Such

mixture can also be used for the protection of the inner surface of concrete lined, or of wood or metal, tanks.

Moulding.—It is possible of course to use latex indirectly for moulding purposes by conversion either into a dry rubber mixing or into a dry crumb, the latter being possible for example, by a suitably modified "latex precipitate" process, and then to produce shaped articles either by an ordinary rubber moulding operation or, in the case of crumb, by shaping in a similar type of mould to that used for synthetic resin moulding powders. The articles thus formed can be either of the soft rubber type or ebonite type according to requirements, the main difference being in the proportion of sulphur employed for vulcanization. Moulding of latex by gelation or coagulation to a continuous solid mass in a shaped cavity has two distinct disadvantages, namely, the slowness of complete drying of a wet coagulum of substantial dimensions and the shrinkage which occurs during drying of a coagulum of soft rubber. These disadvantages, however, are obviated and important advantages gained in at least two special cases of this type of moulding. If the latex containing sufficient sulphur is vulcanized to the condition of ebonite in circumstances substantially preventing the loss of the entrained water, the resulting ebonite retains the dimensions of the mould, the water being very finely distributed throughout its mass. On drying, a light brown microporous ebonite is obtained, the pale colour being due to the discontinuity of the surface; pure ebonite dust also is brown. To the naked eye such ebonite has a smooth surface; it can be polished.

After adding a small proportion of a frothing agent such as an alkali soap to compounded latex it is possible to beat this into a froth which by the addition of coagulant with a delayed action, *e.g.* an aqueous suspension of sodium silicofluoride, can be caused to set or gel after pouring into moulds. The resulting gel constitutes a wet unvulcanized rubber sponge of remarkable uniformity of texture. After vulcanizing the ultra accelerated froth gel by immersion of the filled moulds in a bath of hot water the serum and additional water can be removed by squeezing or centrifuging, followed by drying which occurs rapidly. In this way it is possible to produce as single units sponge rubber cushions, arm-rests, back rests, seats, "squabs", etc. or mattresses of any desired shape, as well as simpler small articles of all kinds, such as household sponges, heel supports, etc. This new method for making rubber sponge is one of the striking developments in the application of latex.

The frothed latex can also be used in other ways, *e.g.*, for dipping purposes, so as to produce articles with a soft sponge-rubber covering; it can also be spread, for example, to form a backing for carpets to provide increased softness and resilience. Another striking application is in the preparation of moulds for the production of ornamental cement castings such as are popular in gardens. The pliability of the sponge enables the removal of castings with undercut portions such as are difficult to obtain with any other type of mould. The frothed latex is cast in the first place to produce the necessary matrix and after vulcanization and drying is ready for use.

Application of Latex to the Protection of Metals etc.

In many of the above processes it will be seen that the latex is deposited initially on a shaped former from which it is subsequently removed. If desired it is also possible to secure the latex in position so as to impart protection of the under-surface against corrosion by the atmosphere or chemical agents, and for this end latex has obvious advantages over rubber sheet which can be applied only to geometrically simple surfaces. If the protective film is to be of ebonite mere vulcanization to the hard condition alone may impart sufficient firmness of adhesion particularly if the under-surface is of copper or has been copper coated. For the ultimate firm attachment of the latex deposit to metals special compounding ingredients, *e.g.* haemoglobin can be helpful, but generally it is advisable to apply a preliminary film of adhesive capable of providing a strong bond between the metal and the rubber.

In the above discussion of the industrial uses of rubber latex reference has been made particularly to natural latex and its modifications. It must be remembered however that artificial "latex" can be produced by the dispersion of rubber (new or even "reclaimed") and that similar processes can be applied to artificial latex and to the natural product.

Eventually for certain purposes it may prove economical to ship dry rubber from the plantations with saving in transport costs and to emulsify the product in the home factory to give "latex" of the desired degree of alkalinity and stability. An obvious disadvantage is that the rubber during and possibly also before the emulsification or dispersion process would necessarily be submitted to some degree of milling or mastication with impairment of the strength of the latex rubber. However, a maximum of tensile strength is not always the main requisite.

At one time there was a tendency for prospective users of latex to follow the lines of the ordinary methods of rubber manufacture; it was, for example, frequently suggested as sufficient advantage to mix the latex (either containing its natural proportion of rubber or in a concentrated form) with compounding ingredients of the standard type and then to convert the mixture directly to an unshaped condition for concurrent moulding and vulcanizing by existing works processes. In the light of experience, however, two distinct fields of manufacture can now be discerned for one of which dry rubber still has economic advantages, while latex offers attractive possibilities in the other. An outstanding feature of latex is that it renders possible new lines of manufacture and new methods for which ordinary rubber is unsuitable. Some evidence of this has been indicated in the foregoing. Latex indeed is finding application on a very considerable scale in industries which in the past were regarded as quite outside the rubber industry. It is always unsafe to prophesy, but there is a distinct likelihood that the most important lines of development of latex manufactures will be supplementary to rather than competitive with the old-established "heavy" rubber industry.

Departmental.

FROM THE DISTRICTS.

The Weather.

The weather during the month showed no marked departure from the normal, being moderately dry throughout the Peninsula except for the coast of Malacca and Negri Sembilan, where precipitation showed the increase which generally occurs in July over this restricted area.

In general the rainfall was slightly in excess of the average for July in North Perak, Negri Sembilan and Pahang.

Remarks on Crops.

Rubber. The highest and lowest prices in dollars and cents per pikul recorded during the month for small-holders rubber were :—Smoked Sheet $10 to $20; Unsmoked Sheet $7 to $19; Scrap $2 to $8. The average Singapore price for small-holders rubber is not to hand for comparison but Penang prices for Unsmoked Sheet ranged from $12 to $18.40 as compared with a range for June of from $11.20 to $14.

Reports record a very definite increase in tapping generally throughout the country as the result of the continued rise in price of the commodity. The tendency towards clearing undergrowth from small holdings reported last month has become more pronounced and is general everywhere.

Padi. The price at the Government Rice Mill has risen slightly to $1.70 a pikul for padi. Activities in preparation of land and sowing of the new crop is reported from the important padi areas of Kedah, Province Wellesley and Krian. In Negri Sembilan, transplanting is practically completed except for Kuala Pilah district whilst in Malacca transplanting is in progress in the Jasin and Alor Gajah districts and the preparation of land is well forward in the coast mukims. In Kelantan, planting of the deep alors is almost complete and nurseries are being established in other localities. In this State the planting of dry padi became general towards the end of the month when favourable weather for the operation was experienced. The planted crop in Selangor, Pahang and the major portion of Negri Sembilan is reported to be making good progress.

In parts of Larut and Kuala Kangsar districts of Perak, and the Kuala Pilah districts of Negri Sembilan, padi cultivation operations are suffering some delay from rival claims on the time of the cultivator provided by a ripening fruit crop and the rise in the price of rubber, which has had the effect of inducing increased interest in the rubber crop at the expense of the padi crop.

The attempt at the production of a short inter-season padi crop at Sri Menanti in Negri Sembilan is not proving very successful owing to lack of

interest by the cultivators concerned, who appear to have entered into the project in a very half hearted manner. Since being planted, the crop has been almost entirely neglected.

Coconuts and Copra. A report to hand from the Agricultural Field Officer, Selangor, states that at present some 7,750 pikuls of copra are being turned out monthly from small-holders kilns in Selangor which represents about 30 per cent. of the entire output of copra from the small holdings of the State. Of the amount mentioned about 1,000 pikuls is good qualtiy copra of or above average estate quality.

Although developments are not on such a large scale elsewhere, encouraging reports are to be hand of real progress in Province Wellesley, where four out of five approved pattern kilns, operated by small-holders, are regularly turning out copra of average estate quality and another kiln is being erected.

The venture at Temerloh is proving a success and copra of average estate quality is being produced. This has encouraged other small-holders to commence the erection of a second kiln.

Progress is Bagan Datoh district of Perak is slow. The one fairly large brick kiln is producing a good quality article, but the work of erecting further kilns has made little further advance. In the class for small-holders copra at the Kuala Lumpur Exhibition the first prize was won by one of the improved kilns in Selangor and the second by the kiln at Temerloh.

Tobacco. A recent attempt at the Singapore Agricultural Station to flue cure virginian leaf in a manner that will produce yellow cigarette tobacco has been partially successful. A proportion of the cured leaf is of a pleasing colour and cigarettes were prepared from it and exhibited at the Departmental Exhibit at Kuala Lumpur M.A.H.A. Show.

During the month 120 pikuls of cured leaf prepared from tobacco grown in Province Wellesley was sold in Penang. In this island an increase in price has led vegetable gardeners again to exhibit interest in the crop as a rotation.

In Perak, there are some six acres under the crop at Selama and several scattered small areas in Kuala Kangsar district, but the main tobacco area is in the vicinity of Chemor where it is estimated there are some 300 acres. Elsewhere in South Perak some 150 acres are under this crop.

Prices for cured leaf in Penang are from $35 to $40 a pikul: in Taiping $40, whilst at Bidor as much as $58 was paid during the month for first grade cured leaf.

Agricultural Stations.

Tobacco is being harvested and cured at Bukit Mertajam Station. The varieties under trial are Local, Deli, Burmese, Havana and Thattayou. At

Kuala Kangsar Station, a fresh planting of tobacco has just been made. In Negri Sembilan, further progress has been made in improvements to Rembau Station and the layout of the Kuala Pilah Station.

Padi Stations and Test Plots.

At Titi Serong, the second transplanting of 7—7½ months varieties was completed and the nurseries of short term padi sown. At Pulau Gadong, short season varieties were sown and satisfactory progress was made with cultivation preparatory to planting. The programme for the mechanical cultivation trials was unavoidably delayed owing to trouble experienced with the tractor. Work is well forward on all the Test Plots.

DEPARTMENTAL NOTES.

Visits and Tours.

The Director of Agriculture, Dr. H. A. Tempany, C.B.E., visited Singapore on July 27th. and attended a conference with representatives of the Pineapple Packers Association held for the purpose of discussing certain questions relating to the improvement of the pineapple industry in Malaya. The Director also had interviews with the Hon'ble the Colonial Secretary and other Officials.

The Chief Field Officer, Mr. F. Birkinshaw, visited Pahang West at the end of June and inspected the progress of the Agricultural Stations. He also visited Cameron Highlands, accompanied by the Senior Assistant Agriculturist, Mr. J. N. Milsum, from July 18th. to 21st., and inspected the Experiment Station at Tanah Rata.

Mr. R. A. Altson, Assistant Mycologist, visited Pahang on June 26th. in connection with oil palm diseases.

The Acting Senior Agricultural Officer, Mr. F. R. Mason, made a tour of inspection in Perak Central and South from 10th to 15th July.

Agricultural Advisory Committee.

A meeting of the Agricultural Advisory Committee was held at the Head Office of the Department of Agriculture, Kuala Lumpur, on June 13th.

The Chairman, Dr. H. A. Tempany, C.B.E., on behalf of the meeting, expressed a welcome to the Hon'ble The Undang of Rembau and tendered the felicitations of the Committee on the honour recently conferred on him.

At the meeting, questions relating to copra and coconut research were discussed and the members were informed of the arrangements which have been made to provide for the continuation of research on copra.

Other matters discussed included the following :—

Supply of disinfectants to small-holders for the control of mouldy-rot disease of rubber trees; home-garden competitions; Tea on Cameron Highlands; the encouragement of poultry keeping by small-holders.

With regard to the latter the meeting was informed of the appointment of Mr. W. H. Barnes as poultry officer for Selangor and Negri Sembilan.

In connection with the Malayan tea industry, it was announced that an exhibit of tea from Cameron Highlands would be prepared and displayed at the Malayan Agri-Horticultural Association's Show in August, and that the market reports on the samples of this tea would then be announced.

Staff Changes and Leave.

Dr. H. W. Jack, M.B.E., has been appointed to act as Chief Research Officer with effect from June 15th. 1933.

Mr. J. H. Dennett has been appointed acting Plant Physiologist with effect from June 15th 1933.

Mr. N. C. E. Miller has been appointed acting Government Entomologist with effect from June 24th. 1933.

Mr. B. A. Lowe has been seconded to Johore for duty as Agricultural Officer, Johore North, as from June 12th. 1933.

Mr. V. R. Greenstreet, Assistant Agricultural Chemist, has been granted leave of absence with full salary, prior to retirement, for 4 months and 28 days from June 30th. 1933.

AGRICULTURAL SHOW IN KELANTAN.

A successful agricultural show was held at Peringat, Kelantan, on June 30th, 1933. The show was the first of its kind to be held in Kelantan, and it attracted a large number of exhibitors and visitors.

The wet padi and rice classes were well supported and the winning copra exhibits were of a surprisingly high standard. Other produce exhibited included rubber, a varied collection of fruits, vegetables, coconuts and coconut oil. The vegetable classes were poor, but in view of the long drought this was to be expected.

The Department of Agriculture, as represented by the Principal Agricultural Officer, Kelantan, Mr. J. A. Craig, staged exhibits illustrating the results of experiments conducted in connection with manuring and varietal trials of padi, and methods of kiln drying of copra. Demonstrations and lectures were given on these two crops, along with demonstrations on plant propagation by budding, grafting, and the etiolation method.

The Department of Irrigation erected two simple and inexpensive water lifts, operated by bullocks, and demonstrated to an interested audience the use of these lifts in irrigating padi land.

The section devoted to home crafts was also well supported and included exhibits of basket and rafia work, embroidery and crochet, and hand made neckties.

In thanking all those who had helped to make the exhibition a success the Acting British Adviser, Mr. A. C. Baker, M.C.S. expressed the hope that the high standard reached by some of the copra, rubber and padi exhibits would act as an incentive to real efforts in improving the quality of Kelantan produce.

Statistical.

MARKET PRICES

July 1933.

Rubber.—The market price for rubber rose considerably during July, opening at 11 3/16 cents per lb. for Spot loose in Singapore and closing at 12 11/16. The average price for the month was 12 11/16 cents per lb. in Singapore, $3\frac{7}{8}$ pence in London and $7\frac{7}{8}$ cents Gold in New York as compared with 10 15/16 cents, $3\frac{3}{8}$ pence and 6 cents Gold respectively in June.

Palm Oil.—The course of the English market during July on a basis of 18 per cent. f.f.a., c.i.f. Liverpool was as follows:—July 1st. £17 per ton; 10th. July, £17; 17th. £17; 29th £17 5s. the market for the month being a steady one. Prices in the U.S.A. landed weight per pound in bulk c.i.f. New York/Philadephia were 3.40 cents Gold on the 1st. July; 3.50 cents Gold on the 10th; 3.75 cents Gold on the 17th. and 3.70 cents Gold on the 29th. July.

The price of palm kernels Fair Average Malayan Quality c.i.f. landed weight on the Continent fell from shillings 9/- per cwt. on the 1st. to shillings 8/6 per cwt. on the 29th.

Copra.—There was a slight fall in price from the 10th. until the 17th. when the market steadied. The highest Singapore price for Sundried during July was $4.10 ped picul on the 3rd., the average price being $3.97 per picul as compared with $4.13 during June. The mixed quality averaged $3.37 per picul as compared with $3.74 in June.

Coffee.—During the month the price at Singapore for Sourabaya coffee was steady, ranging according to grade from $20 to $22 as compared with $21.50 to $24 during June.

Palembang coffee averaged $14.60 during the month having dropped from $15.50 on the 7th. to $14 on the 28th. The average figure for June was $13.90.

Arecanuts.—Palembang's averaged $2.32 and Bila Whole $2.63 per picul as compared with $2.33 and $2.66 during June. The range of Singapore prices for other grades were:—Split $3 to $4.50, Red Whole $3.50 to $5, Sliced $10 to $12.50, Kelantan $4 to $4.50.

Gambier.—Block Gambier increased in price towards the end of the month, the average price being $4.37 per picul. Cube No. 1 averaged $7.62. Corresponding figures for June were $4.64 and $7.40 respectively.

Pineapples.—Values again firmed slightly during July, the average Singapore price per case being; Cubes $3.22, Sliced Flat $3.15, and Sliced Tall $3.39, as compared with $3.09, $3.00, and $3.22 respectively during June.

Tapioca.—The price of Flake fair average $4.20 as compared with $4.12 in June. Pearl Seed averaged $5.19 as compared with $5.37 in June and Pearl

Medium averaged $5.31 as compared with $5.62 in the previous month.

Sago.—Pearl—Small Fair remained steady at around $4.50 as compared with $4.75 in June. Flour—Sarawak Fair averaged $1.91 as compared with $1.90 in June.

Mace.—Prices increased somewhat during the month, the figures being $70 per picul for Siouw and $50 for Amboina. The ruling prices during June were $65 and $45 respectively.

Nutmegs.—There was a slight drop in prices during the month, Singapore price per picul for 110's was $21.25 as compared with $22.75 in June, 80's averaged $29.12 having averaged $31.50 in the previous month.

Pepper.—Average Singapore prices during July were as follows:—Singapore Black $14.69 per picul, Singapore White $26 and Muntok White $26.50, the corresponding prices for June were $17.75, $29 and $29.75 respectively.

Cloves.—As in the previous months the demand for cloves remains small, norminal prices being $40 for Zanzibar and $45 per picul for Amboina.

GENERAL RICE SUMMARY.

June 1933.

Malaya.—Gross foreign imports of rice (including stocks available for re-export) during June 1933, amounted to 43,585 tons, as compared with 46,668 tons in June 1932, of which 46 per cent. were consigned to Singapore, 19 per cent. to Penang, 8 per cent. to Malacca, 21 per cent. to the Federated Malay States and 6 per cent. to the Unfederated Malay States.

Of these imports, 51 per cent. were from Siam, 43 per cent. from Burma, 4 per cent. from Indo-China and 2 per cent. from other countries.

Total foreign exports of rice from Malaya in June 1933, were 11,995 tons (including 377 tons local production) as compared with 12,393 tons in June 1931.

Of these exports 83 per cent. were consigned to Netherlands India and 17 per cent. to other countries.

Net imports for the period January to June 1933, were 200,671 tons as compared with 209,482 tons during the same period for 1932, a fall of 4 per cent.

India and Burma.—Total foreign exports of rice during May 1933, were 230,000 tons as compared with 205,000 tons in the previous month and 239,000 tons in May 1932.

Siam.—Exports (approximate) during June 1933, amounted to 120,345 tons as compared with 130,564 tons in June 1932.

Netherlands India, Java and Madura.—For the period end of May 1933, the area harvested amounted to 4,786,000 acres a decrease of 219,000 acres or 4 per cent. as compared with the corresponding period of 1932: the area damaged was 187,000 acres an increase of 22,000 acres or 13 per cent. as compared with 1932, and additional plantings awaiting harvesting amounted to 3,950,000 acres an increase of 673,000 acres or 10 per cent.

French Indo-China.—Entries of padi at the port of Cholon from January to June 1933, amounted to 667,838 metric tons, an increase of 27,416 tons or 4 per cent. as compared with the same period of 1932.

Exports of rice from Saigon for the period January to June 1933, totalled 788,276 tons, an increase of 152,390 tons or 24 per cent. as compared with the corresponding period of 1932.

Europe and America.—Quantities of rice shipped from the East were:—

(*a*) To Europe for the period January 1st to June 22nd, 752,076 tons, a rise of 207,065 tons or 38 per cent. as compared with the same period of 1932. Of these shipments 53 per cent. were from Burma, 3 per cent. from Japan, 37 per cent. from Saigon, 6 per cent. from Siam and 1 per cent. from Bengal as compared with 62 per cent. from Burma, nil from Japan, 31 per cent. from Saigon, 3 per cent. from Siam and 4 per cent. from Bengal in 1932.

(*b*) To the Levant, period January 1st to May 22nd, 16,691 tons, a fall of 17,402 tons or 51 per cent. as compared with the same period of 1932.

(*c*) To America and the West Indies for the period January 1st to May 17th, 62,351 a decrease of 5,487 tons or 8 per cent. as compared with the same period of 1932.

MALAYAN AGRICULTURAL EXPORTS, JUNE 1933.

PRODUCT.	NET EXPORT IN TONS.				
	Year 1932	Jan-June 1932	Jan-June 1933	June 1932	June 1933
Arecanuts ...	20,280	13,481	10,613	2,861	1,428
Coconuts, fresh† ...	108,123†	63,787†	48,794†	9,578†	11,129†
Coconut oil ...	11,932	5,187	9,443	925	1,536
Copra ...	97,464	37,054	39,095	8,486	3,344
Gambier, all kinds ...	2,925	1,502	1,217	224	177
Palm kernels ...	1,248	526	792	40	180
Palm oil ...	7,892	3,176	4,093	425	340
Pineapples canned ...	66,291	37,202	32,674	6,137	8,097
Rubber § ...	417,137	200,321	208,747	30,701	39,552
Sago,—flour ...	10,267	5,188	1,934	1,072	98
„ —pearl ...	3,128	1,228	1,049	102	163
„ —raw* ...	4,148*	2,080*	2,037*	619*	393*
Tapioca,—flake ...	9,028	4,521	6,008	595	896
„ —flour ...	392	163*	141*	87*	40
„ —pearl ...	19,977	10,448	7,975	1,964	1,023
Tuba root ...	165½	50	231	½	49

† hundred in number. § production. * net imports.

MALAYA RUBBER STATISTICS

Acreages of Tappable Rubber not Tapped on Estates of 100 Acres and over, for the Month ending June, 1933

State or Territory	Acreage of Tappable Rubber end 1932	Estates which have entirely ceased tapping		Estates which have partly ceased tapping		Total (3) + (5)	Percentage of (7) to (2)
		Acreage	Percentage of (3) to (2)	Acreage	Percentage of (5) to (2)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Straits Settlements :—							
Province Wellesley	44,734	1,725	3.8	8,220	18.4	9,945	22.2
Dindings	6,969	209	3.0	1,087	15.6	1,296	18.6
Malacca	111,780	5,315	4.7	20,070	18.0	25,385	22.7
Penang Island	1,635	776	47.5	180	11.0	956	58.5
Singapore Island	28,269	10,877	38.5	4,767	16.8	15,644	55.3
Total S.S. ...	193,387	18,902	9.8	34,324	17.7	53,226	27.5
Federated Malay States :—							
Perak	250,951	10,475	4.2	34,042	13.5	44,517	17.7
Selangor	308,379	18,079	5.8	41,545	13.5	59,624	19.3
Negri Sembilan	228,541	15,739	6.9	19,899	8.7	35,638	15.6
Pahang	38,141	7,870	20.6	4,926	12.9	12,796	33.5
Total F.M.S. ...	826,012	52,163	6.3	100,412	12.2	152,575	18.5
Unfederated Malay States :—							
Johore	325,747	38,717	11.9	32,373	9.9	71,090	21.8
Kedah (*a*)	114,551	8,909	7.8	6,985	6.1	15,894	13.9
Kelantan	21,175	9,560	45.1	1,500	7.1	11,060	52.2
Trengganu (*b*)	4,352	Nil	Nil	2,072	47.6	2,072	47.6
Perlis (*a*)	957	177	18.5	542	56.6	719	75.1
Total U.M.S. ...	466,782	57,363	12.3	43,472	9.3	100,835	21.6
Total Malaya ...	1,486,181	128,428	8.6	178,208	12.0	306,636	20.6

Notes :— (*a*) Registered companies only and are rendered quarterly.

(*b*) Registered companies only.

The above table together with a Summary, was prepared and published by the Statistics Department, S.S. and F.M.S. in July 1933.

MALAYA RUBBER STATISTICS — TABLE I

STOCKS, PRODUCTION, IMPORTS AND EXPORTS OF RUBBER, INCLUDING LATEX, CONCENTRATED LATEX AND REVERTEX, FOR THE MONTH OF JUNE, 1933 IN DRY TONS.

Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports				Exports including re-exports				Stocks at end of month		
								during the month		January to June 1933		during the month		January to June 1933				
	Ports	Dealers	Estates of 100 acres and over	during the month	January to June 1933	during the month	January to June 1933	Foreign	From Malay States Labuan	Foreign	From Malay States Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
MALAY STATES :—																		
Federated Malay States ...	...	12,729	10,664	11,816	64,676	10,192	48,647	Nil	Nil	Nil	Nil	12,346	8,655	79,549	37,258	...	12,758	11,632
Johore ...	...	2,820	3,294	3,777	21,018	4,218	24,920	Nil	3	Nil	20	1,450	6,561	6,689	39,170	...	2,924	3,177
Kedah ...	...	495	2,047	2,443	13,393	1,428	7,261	Nil	Nil	2	Nil	1,224	2,614	6,711	14,636	...	516	2,059
Perlis ...	...	24	10	6	47	8	47	Nil	Nil	Nil	Nil	Nil	23	Nil	114	...	15	10
Kelantan ...	...	287	138	208	918	555	2,565	Nil	Nil	75	Nil	50	707	422	2,986	...	266	165
Trengganu ...	...	55	50	130	672	65	335	Nil	Nil	Nil	Nil	Nil	195	Nil	1,007	..	55	50
Total Malay States	...	16,410	16,203	18,380	100,724	16,466	83,775	Nil	3	77	20	15,070	18,755	93,371	95,171	...	16,534	17,093
STRAITS SETTLEMENTS :-																		
Malacca ...	...	3,902	1,373	1,339	7,619			1		10		3,368		24,625		...	3,797	1,360
Province Wellesley	...	955	517	5,65	2,913			Nil		Nil						...	1,370	683
Dindings ...	...	32	99	98	556	2,536	12,269	Nil	18,804	Nil	95,391	5,566	Nil	36,174	Nil	...	29	107
Penang ...	1,362	3,940	5	4	13			778		3,171						1,748	4,417	7
Singapore ...	3,131	24,554	134	164	878			11,667		43,014		17,435		93,091		6,513	28,538	135
Total Straits Settlements	4,493	33,383	2,128	2,170	11,979	2,536	12,269	12,446	18,804	46,195	95,391	26,369	Nil	153,890	Nil	8,261	38,151	2,292
TOTAL MALAYA	4,493	49,793	18,331	20,550	112,703	19,002	96,044	12,446	18,807	46,272	95,411	41,439	18,755	247,261	95,171	8,261	54,685	19,385

TABLE II
DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
20	21	22	23	24	25	26
DRY RUBBER	9,311	22,711	3,776	4,932	1,050	190
WET RUBBER	3,447	5,827	641	264	1,874	326
TOTAL ...	12,758	28,538	4,417	5,196	2,924	516

TABLE III
FOREIGN EXPORTS

PORTS	For month	January to June inc. 1933
Singapore ...	26,963	146,597
Penang ...	9,017	57,377
Port Swettenham.	5,080	36,160
Malacca ...	379	7,127
MALAYA ...	41,439	247,261

TABLE IV
DOMESTIC EXPORTS 4

AREA	For month	January to June inc. 1933
Malay States ... / Straits Settlements	29,918	203,316
MALAYA ...	29,918	203,316

Notes :—1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained.

2. The production of estates of less than 100 acres is estimated from the formula : Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month, + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + 10 tons local consumption during the month —[2]—[3]—[4]—[5]—[9]—[10]. For the Straits Settlements, Columns [7] and [8] represent purchases by dealers from local estates of less than 100 acres, reduced by 15% to terms of dry rubber.

3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15%; wet sheet, 25%; scrap, lump, etc., 40%; stocks elsewhere are in dry weights as reported by the dealers themselves.

4. Domestic exports are estimated by deducting the average monthly dry weight of foreign imports over a period of 2 months from the gross foreign exports of the later month, the foreign exports of the Malay States being domestic production.

5. The above, with certain omissions, is the Report published by the Registrar-General of Statistics, S.S. and F.M.S., at Singapore on 22nd July 1933.

METEOROLOGICAL SUMMARY, MALAYA, JUNE, 1933.

Locality	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation, .05 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.						hr.	hr.	%
Railway Hill, Kuala Lumpur, Selangor ...	91.3	71.8	81.5	94	69	87	75	84.7	85.4	6.37	161.8	2.62	10	9	5	1		227.90	7.60	62
Bukit Jeram, Selangor ...	89.5	73.1	81.3	92	70	87	75	86.2	87.5	1.40	35.6	1.14	5	3	2			244.25	8.14	66
Sitiawan, Perak ...	92.7	72.5	82.6	95	70	85	75	85.8	86.4	1.90	48.3	0.55	8	6	2			235.70	7.86	64
Kroh, Perak ...	86.7	68.5	77.6	90	63	79	72	82.2	83.4	6.05	153.7	1.72	14	9	1	3		216.05	7.20	58
Temerloh, Pahang ...	90.6	72.2	81.4	93	69	87	75	85.8	86.5	2.50	63.5	0.69	10	9	1			223.70	7.46	61
Kuala Lipis, Pahang ...	89.5	71.6	80.5	91	67	87	74	84.9	85.4	4.82	122.4	1.87	8	6	3	18		197.15	6.57	53
Kuala Pahang, Pahang ...	88.5	74.6	81.5	91	71	84	77	86.5	86.3	2.07	52.6	0.61	9	7	3			222.10	7.40	60
Mount Faber, Singapore ...	89.0	75.6	82.3	92	70	81	80	82.7	83.2	10.07	255.8	1.98	15	13	2			198.90	6.63	54
Butterworth, Province Wellesley ...	89.0	74.0	81.5	91	70	80	77	85.7	86.3	2.98	75.7	1.59	9	7			1	223.25	7.44	60
Bukit China, Malacca ...	85.7	73.8	79.7	87	69	81	77	83.6	84.4	7.16	181.9	3.58	9	6	5			212.20	7.07	57
Kluang, Johore ...	88.8	71.1	79.7	92	67	83	73	82.3	83.1	6.46	164.1	4.01	12	10	2	8	1	202.80	6.76	55
Bukit Lalang, Mersing, Johore	88.9	72.4	80.7	92	70	86	75	82.6	82.8	6.58	167.1	2.69	9	9	4			229.30	7.64	62
Alor Star, Kedah ...	89.0	74.0	81.5	92	71	81	77	86.4	86.7	5.27	133.9	1.66	13	11	2		1	218.10	7.27	59
Kota Bahru, Kelantan ...	91.0	73.4	82.2	94	71	87	77	85.2	85.5	5.25	133.4	2.36	9	6	2			209.00	6.97	56
Kuala Trengganu, Trengganu	88.7	72.8	80.7	91	70	86	76	84.2	85.4	4.84	122.9	1.05	11	11	3	1		210.00	7.00	56
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. Pahang ...	75.2	63.7	69.5	79	59	71	66	71.8	72.6	2.50	63.5	0.52	9	7	2	1		214.30	7.14	58
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	73.1	54.5	63.8	77	49	68	60	70.3	70	3.96	100.6	2.18	10	10	5			205.95	6.87	55
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	72.8	59.8	66.3	76	58	65	62			4.15	105.4	2.47	9	9				213.25	7.11	57

Compiled from Returns supplied by the Meteorological Branch, Malaya.